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ABSTRACT

Presented is a curriculum guide and teaching activities for a K-12 program in environmental education. The program is based on forty-four important environmental education concepts. These concepts are sequenced according to grade level. Activities to teach each concept are suggested. The concepts are organized around the interdependency of living things. The concepts are further developed with attention to three subthemes, economics and culture, ecology, and management. The document is intended to provide teachers with concepts that should be taught in an environmental education program and to provide direction as to how these concepts may be taught. This work was prepared under an ESEA Title III contract. [Not available in hardcopy due to marginal legibility of original document.] (HB)

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ENVIRONMENTAL EDUCATION

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CURRICULUM AND TEACHING ACTIVITIES

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NOTE

This initial environmental curriculum is being revised and expanded. A panel of scholars, primarily from the University of Wisconsin and representing 40 different disciplines is extending the interpretation of the key environmental concepts presented herein. 46 additional concepts will be similarly interpreted. Dr. David Archbald of the University of Wisconsin and President of the Madison Man-Environment-Communication (MEC) Center, Inc. is coordinator and senior editor of this project.

Additionally, the K-12 curriculum and teaching activities are being further developed, tested, and evaluated through a coordinated program including staff from the MEC Center, Madison School District, other Wisconsin school districts and the University of Wisconsin School of Education.

Revised curriculum materials will be available starting in September, 1970. Inquiries may be directed to:

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PREFACE

This environmental curriculum guide is the culmination of one and one-half years activity of a Title III Elementary and Secondary Education Act project that was granted to Cooperative Educational Service Agency 12 in Portage, Wisconsin.

Concepts that form the basis of the guide are the forty-four most important of 112 environmental education concepts that were identified by Dr. Robert Roth, Professor of Conservation, Ohio State University. Dr. Roth's methodology in identifying the concepts greatly simplified: He reviewed the literature for environmental concepts. He then interviewed 80 University of Wisconsin scholars interested or actively engaged in conservation or environmental education. These individuals represented forty disciplines, including the sciences, humanities, and social sciences. The concepts finally identified were then rated for relevancy to environmental education by a national panel of 350 scholars corresponding to the same forty disciplines as University of Wisconsin scholars. The results were then computer analyzed, which yielded a rank order of 112 concepts from the most to the least important.

To ascertain the grade level that each concept should be introduced, teachers from CESA 12 schools were asked to indicate if they taught that concept at their grade or subject level. These teachers represented all grade levels and subject fields of CESA 12 schools. Of the 112 concepts, this evaluation revealed that the forty-four most important concepts were introduced by Grade 6. The remaining concepts, if taught, were taught in special subject fields and normally at the secondary level.

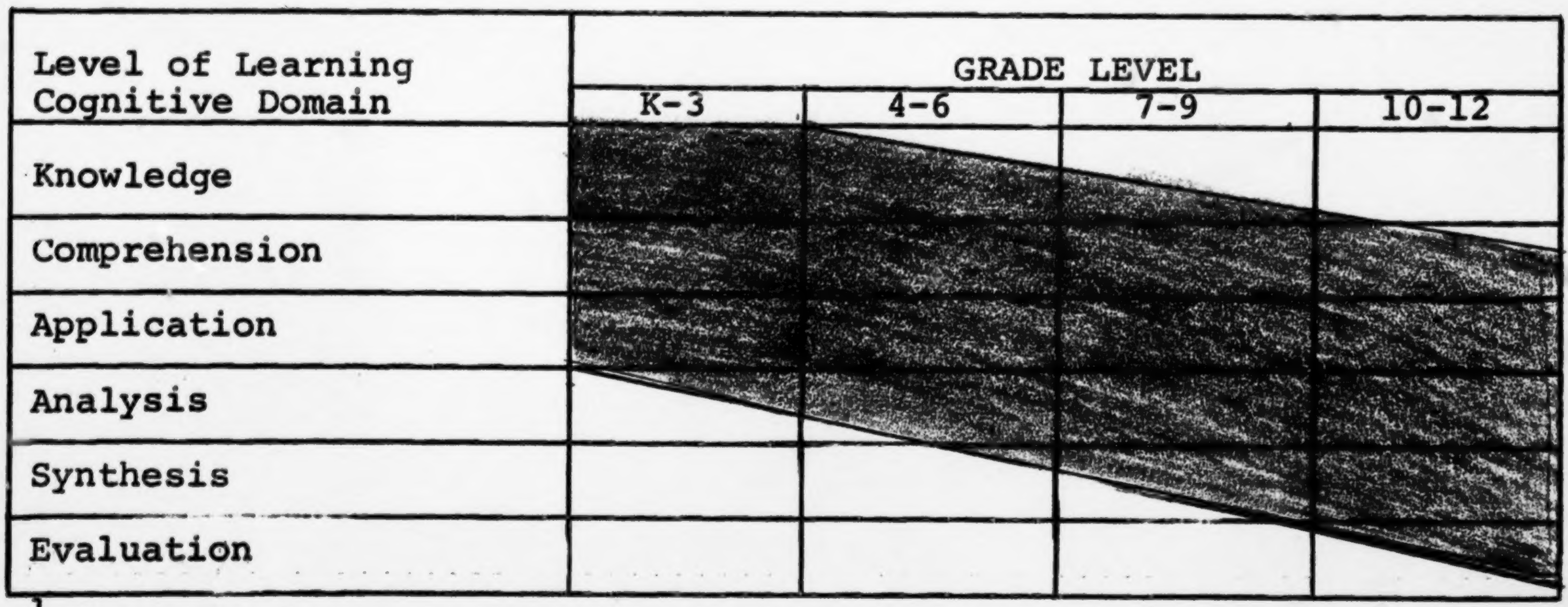
Dr. David Archbald of the University of Wisconsin, developed the background and interpretive materials to accompany the guide.

These materials are designed to provide teachers with a common background when teaching a particular concept.

During the summer of 1969, the guide was pilot tested with students in four CESA 12 schools. Project staff members, functioning as teachers for these sessions, developed learning activities that, whenever possible, incorporated inductive teaching methodology, that is . . . learn by doing.

Following the six-week summer session, two, one-week teacher in-service programs were conducted. Approximately eighty teachers from CESA 12 schools attended these sessions. Upon completion of the in-service program, these teachers worked with the concepts during the 1969-70 school year. Activities that can be effectively used to teach each concept were suggested by these individuals and incorporated into the guide.

Each activity suggested has been classified into one of the six levels of learning categories suggested by Bloom, et al.[1] It is the opinion of the project staff that as a student progresses from kindergarten through grade 12, the kinds of learning experience should progress from the lower level of learning to the high levels. The following chart is used to illustrate this.



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[1] Bloom, B. S., Taxonomy of Educational Objectives, Handbook I: Cognitive Domain, David McKay Company Inc., New York 1956.

To assist teachers in developing new activities for teaching the concepts, the following definitions of each level of learning may be helpful:

Knowledge: Students will be able to recognize or recall specifics.

Comprehension: Ability to translate, interpret, or make predictions.

Application: Ability of students to use abstractions in new concrete situations. The student must remember and apply ideas, rules of procedures, generalized methods, principles and/or theories.

Analysis: The breakdown of a communication into its constituent elements or parts so that the idea is made clear or relationships between ideas are made explicit.

Synthesis: The putting together of elements and parts so as to form a whole not clearly there before.

Evaluation: Judgments about the value on material and methods for a given purpose.

Teachers using the teaching activities suggested in this guide are encouraged to develop behavior objectives for measuring student attainment of the concept. A well developed behavior objective should state three things;

(a) What the student who has mastered the objective will be able to do,

(b) Under what conditions will the students be able to do this,

(c) To what extent the student will be able to do this.

An example of a well written objective might: Given four different leaves from decedious trees, all students will be able to identify three of the leaves without aid of reference materials.

We hope that this guide will serve to provide teachers with the concepts that should be taught in environmental education, and some direction as to how to teach the concept. This guide is not intended to be an end product, but rather a beginning. Evaluation and continuous upgrading of the guide is necessary. Teachers wishing to add teaching activities that have been tried in their classroom with success, are encouraged to submit them to the following address: 412 East Slifer Street, Portage, Wisconsin 53901.

"LIVING THINGS ARE INTERDEPENDENT WITH EACH OTHER AND THEIR ENVIRONMENT"

ECONOMICS & CULTURE

A. THE ECONOMY OF A REGION DEPENDS ON THE UTILIZATION OF ITS NATURAL, HUMAN, AND CULTURAL RESOURCES AND TECHNOLOGIES OVER TIME.

	K - 3	4 - 6	7 - 9	10 - 12
1 - The location of resources affects the economy of a region.	X	X	X	X
2 - The political and economic strength of a country is in part dependent upon its access to domestic and foreign resources.	X	X	X	X
3 - Mans' need for food, fiber, and minerals increases as populations expand.	X	X	X	X
4 - Social and technological changes alter the interrelationship, importance, and uses for natural resources.	X	X	X	X
5 - Increased population mobility is changing the nature of the demands upon some resources.		X	X	X
6 - Supply and demand, in relation to values held by society, determines economic values of resources.		X	X	X

(ECONOMICS & CULTURE)

B. KNOWLEDGE OF THE SOCIAL STRUCTURES, INSTITUTIONS, AND CULTURE OF A SOCIETY, MUST BE BROUGHT TO BEAR ON ENVIRONMENTAL CONSIDERATIONS.

	K - 3	4 - 6	7 - 9	10 - 12
7 - Mans' culture is influenced by the relationships between man and his natural environment.	X	X	X	X
8 - Esthetic resources and recreational facilities are becoming increasingly important in leisure time activities.	X	X	X	X

ECOLOGY

A. ORGANISMS AND ENVIRONMENTS ARE IN CONSTANT CHANGE.

	K - 3	4 - 6	7 - 9	10 - 12
9 - An organisms is the product of its heredity and environment.	X	X	X	X
10 - All living things, including man, are continually evolving.		X	X	X
11 - Even over a long period of time, environments may change at a faster rate than organisms can adapt to them.		X	X	X
12 - In any environment, one component like; space, water, air, or food, may become a limiting factor.	X	X	X	X
13 - Succession is the gradual and continuous replacement of one kind of plant or animal community by another, characterized by gradual changes in species composition.	X	X	X	X
14 - The interaction of environmental and biological factors determines the size and range of species and populations.	X	X	X	X

(ECOLOGY)

	K - 3	4 - 6	7 - 9	10 - 12
15 - Biological systems are described as dynamic because the materials and energy involved are parts of continuous cycles: All life is dependent upon the energy transfers of green plants.	X	X	X	X
16 - Green plants are the basic source of food, clothing, shelter, and energy.	X	X	X	X
17 - At each successively higher level on an energy pyramid, the organic mass is reduced due to metabolic and energy transfer losses occurring at each exchange.		X	X	X

MANAGEMENT

A. NATURAL RESOURCES ARE INTERDEPENDENT, AND THE USE OR MISUSE OF ONE WILL AFFECT OTHERS.

	K - 3	4 - 6	7 - 9	10 - 12
18 - All resources are vulnerable to depletion in quantity, quality, or both.	X	X	X	X
19 - Natural resources are important economically, aesthetically, and biologically.	X	X	X	X
20 - Mans' ability to reason enables him to change his environment.	X	X	X	X
21 - Options available to future generations must not be foreclosed.		X	X	X
22 - Environmental management involves the application of knowledge from many different disciplines.		X	X	X
23 - Optimum environmental management is dependent upon a well-informed public.		X	X	X
24 - Natural resources are unequally distributed over the earth's surface.	X	X	X	X

(MANAGEMENT)

	K - 3	4 - 6	7 - 9	10 - 12
25 - The management of nonrenewable resources involves using of all known methods to maximize benefits to the most people over time: Minerals are nonrenewable resources.	X	X	X	X
26 - The rate of use of a nonrenewable natural resource is dependent upon supply and demand.	X	X	X	X
27 - The rate of resource use can be slowed by the development and adoption of alternatives.	X	X	X	X
28 - The amount of precipitation available for use by man varies with topography, land use, and applied management practices.		X	X	X
29 - As populations increase, competition for the use of water increases, resulting in a need for establishing water use priorities.	X	X	X	X

	K - 3	4 - 6	7 - 9	10 - 12
30 - The quantity and quality of renewable resources can be extended by reproduction, growth, and management.		X	X	X
31 - Soil is classified as a renewable resource, but its natural rate of renewal is extremely slow.	X	X	X	X
32 - Maintaining, improving, and restoring soil productivity is important to human welfare.	X	X	X	X
33 - Soil capability can be maintained by utilizing known agricultural processes.		X	X	X
34 - Land zoning, a practice based on value judgments, may result in land uses which will meet the need of society.		X	X	X
35 - To reproduce the structure of the natural environment is exceedingly difficult.	X	X	X	X
36 - Plants and animals are renewable resources.	X	X	X	X

(MANAGEMENT)

	K - 3	4 - 6	7 - 9	10 - 12
37 - In most countries, wildlife is a public resource.		X	X	X
38 - Wildlife refuges, undisturbed natural areas and preserves may be of value in protecting endangered species, and thus perpetuating the gene pool.		X	X	X
B. SAFE WASTE DISPOSAL IS IMPORTANT IF THE WELL-BEING OF MAN AND THE ENVIRONMENT IS TO BE PRESERVED.				
39 - Environmental contamination can be attributed to increasing human populations, rising standards of living, and the resultant demands for greater industrial and agricultural productivity.	X	X	X	X
40 - Pollutants are produced by natural and man-made processes.	X	X	X	X

(MANAGEMENT)

	K - 3	4 - 6	7 - 9	10 - 12
41 - Water is a reusable and transient resource, but the availability of quality water may be reduced or impaired.		X	X	X
42 - Processes such as erosion and deposition will modify the landscape.		X	X	X
43 - Atmospheric contamination causes physical and chemical changes on earth and affects living things.	X	X	X	X
44 - Man has responsibility to develop an appreciation of and respect for the rights of others.	X	X	X	X

CONCEPT #1

The location of resources affects the economy of a region:

Water, rivers, lakes, and oceans have been a powerful influence in determining locations of cities, and hence in the development of whole civilizations.

The world's earliest cities, Babylonia, and Nineva of Sumaria, developed along the banks of the Tigris and Euphrates Rivers because the rivers provided irrigation water.

Note the location of most of the world's largest cities are on water bodies.

Many other examples exist of local abundant resources affecting the economy: oil in the Middle East, Texas, etc., timber, good agricultural soil, coal, tourism, etc.

As the standard of living has increased, so has man's technological advance, with staggering effects on local resources. The plow and tractor have eliminated more than 99 percent of Wisconsin's original two million acres of prairie - the chain saw has made possible the reduction of whole forests to second growth in a short period (only three percent of California's original redwood forests are now protected.) - strip mining with its harmful side effects - the whole area of pollution is almost wholly a by-product of technological development, and a so-called higher standard of living.

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CONCEPT #1 - The location of a resource affects the economy of a region.

Teaching Activities:

In many areas, certain natural resources are over developed and cause environmental problems. (Man-made lakes are good examples of this.) On a bulletin board, develop illustrations of people benefits and environmental problems to the local community when a resource is "developed". This could also be organized as debate, Pro - benefits of a lake development; Con - environment problems incurred by the development.

CONCEPT #1 - The location of a resource affects the economy of a region.

Teaching Activities:

Provide students with the population, average education attainment, land area and natural resources available for five countries. Have the students arrange the countries according to predicted per-capita income. (Do not name countries) Use countries of a similar size.

Analysis 7-9

CONCEPT #1 - The location of a resource affects the economy of a region.

Teaching Activities:

Utilizing all available information, have students write a theme about the lumber industry and Northern Wisconsin. The theme should include (a) Population changes, Industrial changes, and the effect on the northern economy.

Analysis 7-9

CONCEPT #1 - The location of a resource affects the economy of a region.

Teaching Activities:

Using information taken from the economic profile of their local county, students can list the effects of county natural resources and population changes that has occurred over a 20 year period.

Comprehension K-3

CONCEPT #1 - The location of a resource affects the economy of a region.

Teaching Activities:

Recalling a recent trip or vacation, have students indicate how money that they spent aided the economy of the communities they visited. For each of the expenditures, students should indicate the natural resources that were directly or indirectly responsible.

Comprehension K-3

CONCEPT #1 - The location of a resource affects the economy of a region.

Teaching Activities:

Before class, assemble a number of symbols to represent different occupations such as a tractor to represent farming. Have each child give his father's occupation. List the occupations on a blackboard and give each child the symbol that represents that occupation. When all students have responded, have those holding like symbols stand together. Have one representative from each group count the number in his group. Compare numbers and decide which group is the largest. Then discuss the relationship of the natural resources found in the locality and the type of work fathers do.

Comprehension 7-9

CONCEPT #1 - The location of a resource affects the economy of a region.

Teaching Activities:

Students can contrast the discovery of gold in 1849 in California with the discovery of oil reserves in Alaska in 1969.

Synthesis 10-12

CONCEPT #1 - The location of a resource affects the economy of a region.

Teaching Activities:

Study the affect upon an area when a valuable resource has been discovered. Example; What happened when gold was discovered in California. This study could include, not only the affect upon California, but also on the entire country as people moved westward in search of gold.

Knowledge 4-6

CONCEPT #1 - The location of a resource affects the economy of a region.

Teaching Activities:

Using a world map and population statistics, have students locate major cities. Students should then be asked what natural resources were in part responsible for the establishment of each city. Most of the cities will be located on or near water resources.

Knowledge K-3

CONCEPT #1 - The location of a resource affects the economy of a region.

Teaching Activities:

Have students bring in pictures of recreational activities that people can do in the local community. The recreational activities should be related to natural resources, such as, hunting, fishing, boating, etc. Have the students locate, on a map of the community or area, where those kinds of recreational activities can take place.

Analysis 4-6

CONCEPT #1 - The location of a resource affects the economy of a region.

Teaching Activities:

When studying the early history of the local community, have students determine what natural resources attracted settlers to that location. If possible, take a field trip to examine any historical relics that may still be remaining. For example, water was one of the prime considerations of early settlements, many times mill runs are still in evidence.

Comprehension 4-6

CONCEPT #1 - The location of a resource affects the economy of a region.

Teaching Activities:

Have students make a list of natural resources including several that attract people to the local community. From this list have students suggest which local businesses are in part dependent upon people from outside of the local community buying their goods and services.

Comprehension 4-6

CONCEPT #1 - The location of a resource affects the economy of a region.

Teaching Activities

When the resource that has the greatest effect upon local economy has been identified, students can construct a money exchange diagram that includes all business or services that are related to that resource. Field trips to, or resource persons from these businesses can be utilized.

CONCEPT #2

The political and economic strength of a country is in part dependent upon its access to domestic and foreign resources.

The development of the St. Lawrence Seaway has had a positive affect upon the economy of the City of Milwaukee. Ocean going ships now have access to inland harbors of the cities of the Great Lakes.

India will have many problems in becoming an industrial nation because of the lack of fossil fuel. This is true even though there is an abundance of mineral resources that are needed by industries.

During the Civil War, the North imposed an embargo upon the Confederate States. This embargo was successful in reducing the Confederates access to European products and industrial goods, and limiting the exportation of Southern products. Thus the economy of the Confederate States was greatly weakened.

Great powers have historically been great because of their access to natural resources. The United States is a prime example of a country which is economically strong because of its rich, varied, and accessable resources. Great Britain is a good example of a country that developed an economically strong base because of access to foreign resources.

European countries colonized many underdeveloped countries in Africa and South America because this assured them of access to the resources of that country.

Recently, a high education level of a country's people has come to be recognized as an important domestic resource because sophisticated technological goods and services can be exported. The country of Switzerland is a good example of the above.

One of the contributing factors that led to the Revolutionary War was Great Britain's demands upon the resources of the colonies.

To protect domestic resources and provide economic stability, tariffs are sometimes placed upon imported natural resources and products.

Countries that export end products (radios, watches, etc.), normally will have a higher economy that countries who export unprocessed natural resources. (Japan is a good example of the former, and Latin American countries of the latter.)

CONCEPT #2 - The political and economic strength of a country is in part dependent upon its access to domestic and foreign resources.

Teaching Activities:

Visit a local industry to determine the places that the end products of the industry are sent. (Normally some products will be exported from this country.) At the same time ask personnel of the industry to tell the class where raw materials used by the industry are secured. On two large world maps, indicate where products are sent and where raw material used originate. Students should be able to comprehend that in order for materials to be imported into the United States, a relationship must exist between the USA and the country exporting the materials.

Application 4-6

CONCEPT #2 - The political and economic strength of a country is in part dependent upon its access to domestic and foreign resources.

Teaching Activities:

Using appropriate reference materials, have students identify three countries that are limited in natural resources, but have made extensive use of labor supply and technological know-how to develop economic strength.

Application 7-9

CONCEPT #2 - The political and economic strength of a country is in part dependent upon its access to domestic and foreign resources.

Teaching Activities:

Have students consider all things at home as domestic resources and all things brought into the home as foreign resources. Ask each student to develop a way that they feel they could earn $100 on their own initiative. Many of the ways suggested might use home (domestic resources), other ways will require foreign resources (like lumber to build bird houses to sell). Through this activity they will learn that resources (domestic and foreign) become necessary to help in their efforts to raise money and their economic strength is the ability to buy things to support their program. The political overtones may be brought in by suggestion when discussing the "wealth" of each student in this progress toward reaching the $100 goal, and the wealth of political powers could be compared.

CONCEPT #2 - The political and economic strength of a country is in part dependent upon its access to domestic and foreign resources.

Teaching Activities:

Using the food that the children ate, or items used during the previous day, identify those materials that were imported into this country, and the country of origin. Main theme to be developed here is that as rich in resources as the United States is, we must still import products from other countries. Use a world map and attach yarn to show from which country products come.

Comprehension 4-6

CONCEPT #2 - The political and economic strength of a country is in part dependent upon its access to domestic and foreign resources.

Teaching Activities:

Study in conjunction with a Columbus Day observance. Have students bring to class, spice containers. Use globes and world maps to locate Far East and trace Columbus' journey. Discuss how the access to spices would strengthen Spain's political and economic strength.

Comprehension 4-6

CONCEPT #2 - The political and economic strength of a country is in part dependent upon its access to domestic and foreign resources.

Teaching Activities:

On a bulletin board, construct a list of food items that are locally grown, grown in other parts of the United States, and items that must be imported (with country). Students should be able to understand that in order to import products from other countries, the United States must have a trade agreement with that country.

Analysis 7-9 10-12

CONCEPT #2 - The political and economic strength of a country is in part dependent upon its access to domestic and foreign resources.

Teaching Activities:

Have students study the affects of the Northern blockade upon the Southern economy during the Civil War. This could include methods employed by the North (including diplomatic), the effectiveness of the South's attempt to break the blockade, etc.

Application 10-12

CONCEPT #2 - The political and economic strength of a country is in part dependent upon its access to domestic and foreign resources.

Teaching Activities:

Provide students with the following statement; "As of (date) all tariff restrictions on products imported by the United States are removed." Have students appraise what the affect the removal of tariffs would have on the economy.

Synthesis 10-12

CONCEPT #2 - The political and economic strength of a country is in part dependent upon its access to domestic and foreign resources.

Teaching Activities:

When studying the factors that lead to World War II, students can develop a list of resources that Germany needed that were available in the countries and areas that were occupied. In addition, students could indicate several reasons why World War II may not have occurred if the Common Market had been in existance in 1935-39.

Evaluation 10-12

CONCEPT #2 - The political and economic strength of a country is in part dependent upon its access to domestic and foreign resources.

Teaching Activities:

When North Viet Nam was being bombed by the USA, the Harbor at Haiphong was not a target. Students should determine what the implications might have been had the harbor been bombed.

CONCEPT #3

Mans' need for natural resources increases as populations expand:

The end of the Mesolithic or Stone Age, about 10,000 years ago, is determined by the fact that man turned from being a simple hunter and food gatherer to farming, i.e., planting crops and penning animals. He tended to move away from being a part of nature to being a part from nature. This created some difficulties. When he tried to control nature, he created imbalances with some harsh consequences for man.

Through the discovery of farming techniques, man no longer had to roam in search of food - so he settled down. The Sumerian civilization of Mesopotamia developed in the valleys of the Tigris and Euphrates Rivers. With a relatively large and hitherto unnatural concentration of people in one area, demands for food, shelter, etc., increased proportionately. He irrigated. Soon he stripped the forests from the mountain sides - this combined with overgrazing ended in erosion. His irrigation ditches silted in. The Sumerian civilization died. Nature had struck back.

Man migrated to other areas, taking his newfound technology with him. With increasing populations, man had become dependent on agriculture (monoculture) to meet the increased demand for food. With improved food production, the population increased gradually from about 1/4 billion people in 2,000 B.C. to 1/2 billion in 1 A.D., to 3/4 billion in 1700. Then as medical science and death control advanced, the population shot up to today's 3 billion. It is projected that there will be over 6 billion by the year 2,000. Every week the world gains about 1.5 million additional mouths to feed. The world will not be able to provide sufficient food for that many people. Even now, an estimated 30 thousand people are dying daily of starvation.

Knowledge K-3

CONCEPT #3 - Mans' need for natural resources increases as populations expand.

Teaching Activities:

Have each child bring a picture of a family. (His own preferred) Determine what items are needed by the family and what items the family might want. Cut from a catalog, pictures of these items. Students can predict what would happen if the size of the family increases. Need items would increase . . . want items would have to be put off.

Comprehension K-3

CONCEPT #3 - Mans' need for natural resources increases as populaions expand.

Teaching Activities:

To show how increases in population require additional food, fiber and minerals, make a puppet. Provide the puppet with all the food, clothing, and material comforts that students deem necessary. Make another puppet and discuss what the affects on food, fiber, and material items will be. Students in discussion comprehend two alternatives: either the puppet must share thus lower the amount of items each has or the items must be duplicated causing an increase in use of materials.

Comprehension 4-6

CONCEPT #3 - Mans' need for natural resources increases as populations expand.

Teaching Activities:

To illustrate how food requirements are met in a country such as Japan, where population is large and agricultural land limited, the following can be used; prepare a variety of sea foods such as herring, tuna, clam, etc., and have each pupil sample on a cracker. This will acquaint them with the kind of food that Japanese must eat for protein. Students can determine what foods we eat for protein.

Application 7-9

CONCEPT #3 - Mans' need for natural resources increases as populations expand.

Teaching Activities:

Provide the students with statistics concerning the population, area, and resources of a country. Have students predict the most limiting statistic of that country.

Application 10-12

CONCEPT #3 - Mans' need for natural resources increases as populations expand.

Teaching Activities:

Materials - Flies, easily obtained from biological supply houses, or you may want to try catching them.

Procedure -
(1) Students form teams (as many as you like).
(2) Each team is given a pint jar with growing medium (it would be best to make this as a class so they can see the nutrients and minerals being used).
(3) Each team is then given a different number of 0 and +0 pairs.
(4) Population counts vs. time can then be made. (This would be done after flies were allowed to breed for two weeks, and larva forms appear and turn to adults.

Lesson - As populations increase the demand upon food, etc. increases.

The more individuals using a given amount of resources the faster it will be used up.

Analysis 4-6

CONCEPT #3 - Mans' need for natural resources increases as populations expand.

Teaching Activities:

Gather data from local sources concerning population increase and water usage. Have student construct graphs and determine the relationship between population growth and water use for the community. Students should be able to analyze connection between the percent of increase in water use and a lesser percent of population growth.

Comprehension 7-9

CONCEPT #3 - Mans' need for natural resources increases as populations expand.

Teaching Activities:

As populations increase the need for land to produce food products can be illustrated by having students compare agricultural practices in older countries to agricultural practices in the United States. Other examples that might be discussed are the use of irrigation systems in Central Wisconsin and the draining of marshes in other areas of this state.

CONCEPT #4

Social and technological changes alter the interrelationships, importance, and uses for natural resources.

Early colonial families were primarily rural oriented. Most of their daily needs were satisfied through their own labors. As the country grew, our population become urban oriented and specialized in occupations. Today, 7% of our population provides enough food for the remaining 93% with enough surplus to make the United States a leading food exporting country in the world.

Prior to the invention of the internal combustion engine, petroleum was used primarily as a source for light energy. With the advent of the internal combustion engine, the importance of petroleum reserves has become of paramount importance. Oil companies have paid a total of one billion dollars for mining rights to drill for oil. The entire state of Alaska only cost 7.3 million when purchased from Russia.

At one time, Chile was the world's leading exporter of nitrates. Due to technological development, the nitrogen in the air can be converted to nitrate compounds, thus diminishing the importance of the Chilean nitrate deposits.

The use of coal for home heating was common through the early 20th Century. With more homes today being heated by oil, natural gas, and electricity, the amount of coal used for heating homes has been drastically reduced. However, the coal industry has developed other markets for coal, and the total amount of coal mined each year is increasing rather than decreasing.

Population statistics show that our population is moving away from large metropolitan cities to small communities nearby.

The development of an air terminal in the Florida Everglades may have a tremendous affect upon the whole ecology of the Everglades. To some people it is more important that the air terminal be built without any, or very little, thought toward the ecological consequences.

CONCEPT #4 - Social and technological changes alter the interrelationships, importance, and uses for natural resources.

Teaching Activities:

Class discussions centering around needs versus wants. For example, the number of cars per family, or rooms per family; throw away food containers versus dishes. This discussion should lead to who creates our wants. An excellent example might be television advertising of toys, or the manufacturer who creates electrical devices for the consumer that may satisfy wants, but may not be a needed item.

Comprehension 7-9

CONCEPT #4 - Social and technological changes alter the interrelationships, importance, and uses for natural resources.

Teaching Activities:

Utilizing water-use figures, students can graph consumption rates for their local community. Factors that contribute to increased water consumption can be developed by the class.

Application 7-9

CONCEPT #4 - Social and technological changes alter the interrelationships, importance, and uses for natural resources.

Teaching Activities:

Students can project the effect on the world supply of natural resources if a country were to become highly westernized. For example, if China were to have the same number of automobiles per capita as the United States.

CONCEPT #4 - Social and technological changes alter the interrelationships, importance, and uses for natural resources.

Teaching Activities:

Assume that a small community were to be the location of a large factory employing several hundred people. Have students predict the effect of the sudden rise in population on the natural resources of the area.

Analysis 7-9

CONCEPT #4 - Social and technological changes alter the interrelationships, importance, and uses for natural resources.

Teaching Activities:

A class might list the number of amounts of natural resources that are used in the manufacture of an automobile. A similar list of natural resources that were used in the manufacture of a 1930 auto could be developed and a comparison made.

CONCEPT #5

Increased population mobility is changing the nature of the demands upon some resources:

Projected percent increase in some industries relating to mobility in the U.S.A. by the year 2,000. 1947 = 100%

Population increase = 228%

1. Intercity Freight Transportation = 3,200%
2. Air passenger miles = 2,600%
3. Public construction of highways = 2,000%
4. Residential construction = 1,000%
5. Automobile production (annual) = 730%
6. Total consumption of petroleum = 540%
7. (Gross National Product) = 600%

From the above, it is obvious that far greater demands are going to be placed on many of our resources, and at a faster rate than simple population increase.

Increased air pollution (1) Increased pressure on natural areas, camping sites, lakes, and recreational areas in general; (2), (3), (5). Mounting battles over where highways (3) and new airports (2) will be constructed. Increased pressure on water, air, and land to dispose of waste products from manufacturing (1), (3). Urban sprawl (4) because the society is no longer street-car oriented. People now commute in cars, and apparently will do so increasingly.

Increased mobility, in addition to increasing numbers of people, stems from: (1) more time per person, (2) more per capita vehicles; automobiles, buses, airplanes, recreation boats, ocean liners, (3) greater speed.

Knowledge K-3

CONCEPT #5 - Increased population mobility is changing the nature of the demands upon some resources.

Teaching Activities:

Have students bring a list of the places that they, their parents and grandparents have lived during their first ten-years of life. This should illustrate how much more mobile this generation has been compared to previous generations.

Comprehension 4-6

CONCEPT #5 - Increased population mobility is changing the nature of the demands upon some resources.

Teaching Activities:

Develop a list of resources in the local area that attract tourists. Discuss the affect on the local economy and the affect on other resources in the community, i.e., increased sewage disposal and the water resources.

Analysis 4-6

CONCEPT #5 - Increased population mobility is changing the nature of the demands upon some resources.

Teaching Activities:

What becomes of old cars, buses, airplanes, ships? Why aren't the material resources which built these vehicles used more in rebuilding more new vehicles. What are the economics involved? How many ways can you list that reusing old cars would relieve pressure on some aspects of the environment? How would driving a smaller car with less horsepower help the environment? - using your old car longer?

Application 10-12

CONCEPT #5 - Increased population mobility is changing the nature of the demands upon some resources.

Teaching Activities:

Have students develop a list of materials to build and propel various vehicles, find out miles per gallon for various vehicles, volume of air required to burn a gallon of gasoline in an automobile engine, volume of clean air to make the car exhaust breathable by man.

REPORT FINDINGS TO CLASS. Predict the consequences of more cars, buses, planes, etc., in the U.S.A. and world.

Synthesis 7-9 10-12

CONCEPT #5 - Increased population mobility is changing the nature of the demands upon some resources.

Teaching Activities:

Have students determine (2) amount of materials used per mile of interstate highway, (b) average cost of construction per mile of interstate highway, and (c) the number of acres of land that are necessary per mile of interstate highway. Discuss alternative methods of moving people more cheaply but effectively.

Comprehension 7-9

CONCEPT #5 - Increased population mobility is changing the nature of the demands upon some resources.

Teaching Activities:

From the Natural Resources Department, find out the increase in the number of out-of-state fishing and hunting licenses issued in Wisconsin during the last ten years, and the increase in number of visitors to our state parks. Discuss the relationship between the increased numbers and the demands upon natural resources.

CONCEPT #6

Supply and demand, in relation to values held by society, determines economic values of resources.

If a resource plays little or no role in the economy of a given society, it will be of little or no economic importance to that society. For example, the indians who roamed over the vast Masabi Range did not place any value on its immense iron ore deposits.

A cord of wood in New York City has greater economic value than that same cord of wood in northern Wisconsin because of high demand in New York City, and limited supply.

Our society places a certain esthetic value on flowers, shrubs, and trees. Consequently, the woods on land slated for subdividing for homesite building can have as much or more economic value than the land itself, i.e., it will often sell for more than twice as much as adjacent open fields.

Gold and diamonds have very little utility, but our society places tremendous value on them.

Increasing economic values can also be attributed in either a resource being depleted, an increased demand for that resource, more people demanding it, or a shift in values, or both. An example of both factors combined can be found in the collapse of shellfish production in the Delaware estuary.

	1956	1965	% Fall-Off in Yield
Oysters	4.2 million	34 thousand	over 99%
Delaware Crabs	2.15 million	558 thousand	74%
Delaware Hard Clam Meats	332 thousand	36.9 thousand	89%

The demise of the shellfish was brought about by man-pollution, siltation, and altered salinity which altered the habitat, and in the case of the now weakened oysters, disease increased which killed more.

A major danger to man is that through thoughtless and ignorant "developement" of one resource other valuable resources can be inadvertently destroyed. Or, man can destroy resources which have no apparent value to man - resources whose real values ecologically, medicinally, or other, have simply not been recognized until too late.

Comprehension 4-6

CONCEPT #6 - Supply and demand, in relation to values held by society, determines economic values of resources.

Teaching Activities:

Using appropriate reference materials have students develop the following: (a) important resources at the time of the American Revolution, but not important now; (b) resources important now but not at the time of the American Revoultion; (c) resources important both then and now.

Comprehension 4-6

CONCEPT #6 - Supply and demand, in relation to values held by society, determines economic values of resources.

Teaching Activities:

Have students study the importance of the buffalo in the indian society and contrast with the value placed on the buffalo by the white man. From this information students can determine why the white man was not concerned by decreasing numbers of buffalo.

Comprehension 7-9

CONCEPT #6 - Supply and demand, in relation to values held by society. determines economic values of resources.

Teaching Activities:

Discuss the following:

"We don't miss the water 'til the well runs dry!"

"Water, water, everywhere, but not a drop to drink!" (refers to the ocean but could apply to polluted inland water as well)

How do starchy foods compare in price with high protein foods? Which food type is more easily supplied?

The Masabi Range, 150 ft. tall white pine trees and crude oil held little value to the American Indian but have high value to Americans today. Why?

CONCEPT #6 - Supply and demand, in relation to values held by society, determines economic values of resources.

Teaching Activities:

Walk through the school building. Compare materials used in new construction with materials used in old construction. Have students determine why construction materials have changed. Some changes that might be observed are material used in floor, window sills, door cases, etc.

Synthesis 7-9

CONCEPT #6 - Supply and demand, in relation to values held by society, determines economic values of resources.

Teaching Activities:

Provide the student with the following: A urban dweller is interested in buying property in the country. Two farms are available in an area he is interested in. One farm has some potential for farming land, the other has more potential as a recreation area. Assuming the price is the same, which of the farms would the person from the city probably buy and for what reasons?

CONCEPT #6 - Supply and demand, in relation to values held by society, determines economic values of resources.

Teaching Activity:

Provide the students with the following: A new industrial plant is planned for construction in the local area. The plant will provide employment for over 100 people. Over 1.5 million in tax dollars from this plant will return to the local community. The plant will be 99% efficient in regard to materials being emitted into the air. Water used in the industrial process, when returned to the stream, will be 3° warmer than the stream water. Evaluate what environmental consideration should be made before the plant is built.

Analysis 10-12

CONCEPT #6 - Supply and demand, in relation to values held by society, determines economic values of resources.

Teaching Activities:

Land values have shown a tremendous increase in cost in recent years. Students by conferring with real estate agents construct graphs to show land value increase. The graphs could be constructed for each of the following: farmland, residential property, lake shore property, and timber land. Through analyzing the graphs, students identify various facts that have led to increased land values.

CONCEPT #7

Man's culture is influenced by the relationships between man and his natural environment.

In general, the less technologically advanced (industrialized) the society, the less per capita damage that society does to the natural environment. Associated with industrial products are the host of harmful by-products. For example, consider discharges into rivers and lakes - petroleum, acids, cyanide, phenols, iron, fertilizers, persistent pesticides, oxygen-consuming materials, etc.

Mans' attitudes toward the landscape, respect, or lack of it, are largely determined by his culture. The American Indian, and some other cultures with pagan religions, believed there were spirits in the streams, trees, etc. So, for the most part, he treated his natural environment with respect or even reverence. The Judeo-Christian attitudes, on the other hand, recommend "...be fertile, multiply, and subdue the earth". (Genesis)

We have indeed done a good job in subduing the earth. Unfortunately, we have been, and are being very hasty in producing dollar profits and the associated material comforts. This, plus our ignorance of and/or indifference to ecological consequences, has destroyed many valuable resources - many streams, rivers, lakes, and ocean estuaries; the passenger pigeon (100%), the American Bison (99.9%), almost all of the virgin U. S. forests and prairies, and untold millions of tons of fertile topsoil have been needlessly blown away or washed down rivers.

A current dangerous practice is our exploitation of off-shore oil. The Santa Barbara oil slick is history now, as are many other oil slicks around the world. But even now, over four months after the leak at Union Oil Company's Platform A was sealed, crude oil is still gushing from nearby fault lines in excess of an estimated (exact rate is unmeasurable) 1,500 gallons a day. "Soismic instability in the area also suggests the peril of an undersea earthquake of sufficient force to snap off well casings and sever shorebound pipelines. In one six-week period last summer (1968), just before the start of construction at Platform A., seismologists recorded a total of 66 undersea shocks in the Santa Barbara Channel." LIFE, June 13, 1969.

The point is, how great and how obvious does the environmental damage have to be to persuade man his global subjugation and profit goals perhaps need constant reevaluation.

It is the belief of most people that problems, regardless of magnitude, can be solved through a massive effort of technology and money. The project sponsored by the U. S. Government to place a man on the moon in a ten-year priod of time is a good example. Environmental problems that are facing the world population are different because neither technology nor money can replace an environment once it has been destroyed. If pollution of Lake Michigan waters was stopped immediately, it would require 1000 years for the lake to return to its natural state. Too often the action of our industries and governmental agencies are based upon immediate returns rather than -ong-term consequences.

Knowledge K-3

CONCEPT #7 - Mans' culture is influenced by the relationships between man and his natural environment.

Teaching Activities:

With slight modifications, the following activities can be used for a classroom bulletin board, art activity in both the constructive (clay modeling) and drawing-painting modes, and individual student charts or mini-plays.

Using one or several of the above means of expression, show how the American Indian used his environment to:

(a) make his clothing
(b) decorate himself and his belongings
(c) make his shelter
(d) make his work and play tools
(e) feed himself and his family
(f) obtain items for trade

Analysis 4-6

CONCEPT #7 - Mans' culture is influenced by the relationships between man and his natural environment.

Teaching Activities:

Using one or several of the above means of expression, demonstrate how the American Indian used his environment to carry out any one of the activities, and contrast it to our present means of accomplishing the same thing. Example:

To make an article of clothing, the indian may use sharp bones for needles, animal sinew for thread, animal hides for material with very little other supporting material. Whereas; we would use iron to make needles and sewing machines, coal may be needed for electrical power production, etc.

Analysis 10-12

CONCEPT #7 - Mans' culture is influenced by the relationships between man and his natural environment.

Teaching Activities:

Report on an activity of man which, due to his culture, has enhanced the environment. Follow up with a report which is in contrast to the first; that is, one in which the environment is exploited.

Comprehension 7-9

CONCEPT #7 - Mans' culture is influenced by the relationships between man and his natural environment.

Teaching Activities:

List words or phrases that describe both animal and man -- Hunger, Shelter, Territoriality, Fight, Kill, Pecking order (prestige, power, discrimination), Acquisitiveness, Materialism, (e.g., food caches, pack rat), Greed, Egocentricity (me first) Selfishness.

Are unique to man -- Art, Reason, Writing, Literature, Morality, Ethics, Do Unto Others, Civil Rights, Intellect, Poetry, Aesthetics, Music Appreciation, Voting.

Note: These characteristics peculiar to man alone cause no harm to the environment. It is only when he conjoins his highly developed brain and consequent technology and acts and behaves like an animal, does his relationship to the environment suffer.

Analysis 7-9 10-12

CONCEPT #7 - Mans' culture is influenced by the relationships between man and his natural environment.

Teaching Activities:

Report on leisure activities of man which reflect a definite environmental link. Example:

(a) Utilize records of country-western type music. Note the mood which is reflected by the author from a feeling he has about the environment.
(b) Utilize outdoor hobbies and activities of your students and discriminate between constructive and destructive environmental processes.

For Discussion --
(1) Does our affluence often ignore possible exploitation? (Hunters can afford to fly north to shoot a polar bear)
(2) Are leisure activities becoming more regulated? (Game laws, snowmobile regulations, etc.)
(3) Do any activities help pay for the cost of environmental usage and maintenance? (License fees, snowmobile registration, duck stamps, etc.)

Synthesis 10-12

CONCEPT #7 - Mans' culture is influenced by the relationships between man and his natural environment.

Teaching Activities:

Design ways that you feel businesses that directly affect the quantity and quality of the resources could increase their production and show respect toward the environment. Develop a plan which would help us carry our standard of living into the future with respect toward the environment.

Analysis 10-12

CONCEPT #7 - Mans' culture is influenced by the relationships between man and his natural environment.

Teaching Activities:

Use a resource person (county agent, local business man, extension service personnel, etc.) to help explain progress and principles involved in rural and urban zoning regulations. Visit zoned areas and appraise how man has designated the use of the environment. Be sensitive to environmental safeguards that have been considered and forgotten.

Comprehension 10-12

CONCEPT #7 - Mans' culture is influenced by the relationships between man and his natural environment.

Teaching Activities:

Early man had different impacts upon his environment and hence their degree of culture varied. Compare modern man and his way of transmitting knowledge to succeeding generations by the use of tools, language, and methods of thought to that of any group of early man. Note resources used to help each group in his speech, thought, activities, and his artifacts.

CONCEPT #8

Esthetic resources and recreational facilities are becoming increasingly important in leisure time activities.

Historically, man has fought to fulfill two basic needs as have all other animals - adequate food and shelter. In the "developed" countries he has largely filled these needs for two reasons; first his remarkable technological advancement and, second, because of abundant natural resources in relation to population size. That is, he has fulfilled needs insofar as the present level of social development permits. (Areas of starvation and inadequate housing exist in the poverty areas of all the economically wealthiest nations.)

With a much reduced food-shelter problem in this country, and a greatly increased per capita productivity, 70 and 80 hour work-weeks are no longer the case as was common a hundred or even fifty years ago. Today, forty hours is a normal work week, and 32 hours is sometimes the norm, and the work week keeps shrinking. So, people today have a lot more free time which they can devote to recreation - doing what they want to do, i.e., leisure.

This same technology which shortened our work week also reduced infant mortality and lengthened adult life. This produced today's phonomenal birthquake. Then too, let's not forget technology has given us more cars, highways, and air travel capability (See Concept 4). To assess increased pressure on recreational facilities, we must then multiply the number of additional leisure house times the number of additional people times increased mobility factor. Already, to use some national parks, one must sign up a year in advance. Where is the limit? Or, have we passed it and simply do not yet recognize it? (One must remember that the technological-material society is polluting the environment at an ever-increasing rate. While we destroy more fish and game habitat, we create more people with more time to fish and hunt, swim and boat, hike and camp. More thoughtful decisions must be made on how much of the natural environment we are ready and willing to sacrifice to "progress" - progress to where? Is it possible natural esthetics, literature, the arts, and other non-material endeavors might not only be better substitutes for things material, but simply better?

Comprehension K-3

CONCEPT #8 - Esthetic resources and recreational facilities are becoming increasingly important in leisure time activities.

Teaching Activities:

Have a map of Wisconsin, the United States, and the world on display. Ask each child to name a place the family spent time at while on vacation. In kindergarten, children may have to bring a note from home stating some area the family had visited. As each child indicates the place they have been, place a name tag, with that child's name on it, on the appropriate map. Then note the type of area and facility that was visited, like woods, lake, park, etc. These could be tallied to see which type of area was used most by the class members.

Comprehension 4-6

CONCEPT #8 - Esthetic resources and recreational facilities are becoming increasingly important in leisure time activities.

Teaching Activities:

Conduct a classroom survey which would compare the number of hours spent in various life activities by members of the class. Compare to their parents and grandparents as to the amount of time spent in doing similar activities. Note how leisure hours were spent by the older generations compared to students of today.

Analysis 4-6

CONCEPT #8 - Esthetic resources and recreational facilities are becoming increasingly important in leisure time activities.

Teaching Activities:

Beauty is in the eye of the beholder. Use a field trip to stimulate an awareness of the types of things in the environment which could offer beauty. This brings out the important point that one can perceive beauty in the area of the familiar; around home, school, and routes to and from school. Beauty can be the seasonal sounds, colors, animals, and plants. Each student can then identify the things which to them was something beautiful.

Analysis 7-9

CONCEPT #8 - Esthetic resources and recreational facilities are becoming increasingly important in leisure time activities:

Teaching Activities:

Have students research (interview one, two, three people) regarding their activities on their last vacation. Identify esthetic resources and recreational facilities used. How many of those interviewed used water resources to enhance their vacation? Have students ask those interviewed what they consider "quality" in the environment.

Analysis 7-12

CONCEPT #8 - Esthetic resources and recreational facilities are becoming increasingly important in leisure time activities.

Teaching Activities:

Assume that class is to be dismissed today and all students would be on an immediate two-week, all expense paid, vacation:

- Make a list of where students would go (transportation required, See Concept 4)
- What would they do (recreation facilities required)
- How many of the facilities identified harmonize and how many conflicts with factories, houses and stores
- What kinds of man activities will encroach on the resources and recreation facilities identified
- List what students consider "quality" in the environment
- What must be done to maintain the various definitions of quality

Analysis 10-12

CONCEPT #8 - Esthetic resources and recreational facilities are becoming increasingly important in leisure time activities.

Teaching Activities:

As the demand for more esthetic resources and recreational facilities increases so also is there a request for more public access to such areas. Examine the types of problems which arise over the issue of public access. Identify problems and responsibilities which lie with the landowner and those which belong to the invading public.

CONCEPT #8 - Esthetic resources and recreational facilities are becoming increasingly important in leisure time activities.

Teaching Activities:

Analyze leisure activities which require a use of the natural environment and identify those avocations which tend to conflict in their use of a similar area. Propose ways in which these conflicts may be solved or are being solved at present.

CONCEPT #8 - Esthetic resources and recreational facilities are becoming increasingly important in leisure time activities.

Teaching Activities:

Analyze brochures from local, state and national parks and monuments. Formulate a set of conditions which are inherent in the areas designated as leisure, rest and enjoyment usages. Using the above guidelines and a map of your local area, propose regions which you feel would best serve mankind as a recreational area.

CONCEPT #9

An organism is the product of its heredity and environment.

Heredity - From little acorns great oaks grow (not hickories). All living organisms, including man, are the end products of millions of years of evolution. Mans' heredity gives him senses geared to the natural environment. Hence, our natural response to, and enjoyment of, natural areas.

Environment affects organisms through such factors as: temperature, length of day, light (cave, woods, prairie), wind dust, precipitation (kind, amount, distribution), humidity, space, food (for animals), nutrients (for plants), noise, visual.

Most of the above run along gradients.

Examples:

Space - open grown vs. forest grown oak

Mans' speech, clothes, politics, religion, etc.

CONCEPT #9 - An organism is the product of its heredity and environment.

Teaching Activities:

No other concept probably offers as much opportunity for experimentation than this one. At any age level, plants can be grown in a variety of environments and with proper controls, a valuable lesson can be demonstrated. Seeds or started plants can be used, both of which could be obtained from commercial sources or from nature. (Watch for protected species.) Comparison of soil types, temperatures, soil pH, wave lengths of light, amount of light, etc., are just a few variables which may be tested to discover its affects on plants. Containers to hold plants may be milk cartons to plant the plants obtained from greenhouse operators.

Analysis 4-6

CONCEPT #9 - An organism is the product of its heredity and environment.

Teaching Activities:

Investigate hereditary characteristics found in plants and animals which enable them to survive in their environment. Such things as protective coloration, mimicry, and physiologial changes as in the kangaroo rat which enables them to survive with little intake of water.

Analysis 7-9

CONCEPT #9 - An organism is the product of its heredity and environment.

Teaching Activities:

Experiments with fruit flies, to demonstrate both the environmental and hereditary aspect of this concept, are especially appealing to children. By crossing fruit flies with easily observed traits (red-eye-white eye), you can make interesting observations on new generations in a short period of time. Also, the metamorphic stages are easily seen. (Most Biology Teacher Handbooks have instructions on raising and breeding this interesting creature.)

Application 7-9

CONCEPT #9 - An organism is the product of its heredity and environment.

Teaching Activities:

The affects of environmental and hereditary factors can be demonstrated by using tobacco seeds (from biological supply houses) and testing the affects of light and darkness on them. (Tobacco seeds work well because they are so small and many will fit in a small container.)

Procedure:

(1) Have each student, or team, put 50 seeds in each of two Pretrie dishes which contain moist paper toweling.
(2) Put some dishes in the dark and some in the light.
(3) After germination, note colors of cotyledons, count numbers of each color. Record data.
(4) After counting, reverse light conditions, (put those in the dark in the light, etc.). Allow to stand for a few days.
(5) Again note color of cotyledons, and count numbers of each color.

Application 7-12

CONCEPT #9 - An organism is the product of its heredity and environment.

Teaching Activities:

Conduct an ecological field study to investigate the types and numbers of living organisms (plant and/or animal) found in a variety of areas. You may investigate as many areas, and organisms as time and age group permit. This can be done on campus by comparing types of organisms on the north and south sides of buildings. Areas to be compared might be - wetlands, uplands, natural grasslands to agricultural fields, shady areas, sunny areas, ponds, streams, birds in upper story of forests to birds on ground in same forest, etc.

Comprehension 4-6

CONCEPT #9 - An organism is the product of its heredity and environment.

Teaching Activities:

On a field trip, either to the school land laboratory or on the school grounds, discuss and point out various environmental or hereditary conditions that affect the kinds of organisms found in various locations. Examples might be shade tolerant trees (white pine) as opposed to sun loving species like jack pine, or trees of equal age - some small and others large. Have students determine if certain conditions are caused by heredity or environment.

CONCEPT #10

All living things, including man, are continually evolving.

Darwin - Gallapagos Islands recognized divergent evolution of several species as a result of species isolation.

All populations, whether a colony of ants, field of corn, flock of ducks, or groups of people have genotypic (gene) and phenotypic (appearance) differences. The larger the population the greater the variability. For example, if the people of Portage repopulated the state of Wisconsin, both the gene makeup and appearance of the new Wisconsin population would be much more uniform than the present Wisconsin population.

This point is used to advantage in, for example, corn breeding programs. A new high-yielding strain represents only a tiny percent of the original corn germ plasm from which it has been developed. It is now very uniform in its high yield as well as other physical and physiological characteristics.

Naturally, species with greater genetic variation are proportionately better able to adapt to changing environmental demands.

Evolution has been going on here on earth for two billion years - since the appearance of the amoeba - and continues today.

As a new combination of genes provides an individual or group of individuals with a competative advantage, it is that gene combination that tends to be reproduced. Because there are always many ways in which any species can be better adapted and in closer harmony with its environment, it is those gene combinations which will be perpetuated.

The environment constantly tests changes in heredity. Chance changes in genes result in new characteristics which may or may not be an advantage in the environment present. Only those which are an advantage persist in the population long enough to become "adaptations". If environment changes, this may give an advantage to individuals with changed characteristics. Extreme adaptations make organisms especially vulnerable when environment changes. Adaptability to meet new situations is the best survival insurance.

Insects treated with insecticides are a good example of continual evolution. Many resistant strains have evolved. This has unfortunately resulted in use of increased quantities of the insecticides as their effectiveness decreases.

Man takes advantage of new hereditary characteristics in developing agricultural varieties - managing evolutionary process to benefit man.

Synthesis 10-12

CONCEPT #10 - All living things, including man, are continually evolving.

Teaching Activities:

Students enjoy the challenge of culturing bacteria, and these organisms offer an excellent chance to look for evolutionary changes in a short period of time. (See Biology Teachers Handbooks for bacteriological techniques)

General Procedure:

Culture harmless species of bacteria (serratia marceseus or sarcina luted are good) on nutrient agar to which a known quantity of an anti-biotic has been added. (Antibiotic can be obtained from doctors, hospitals or veterinarians). Different quantities of antibiotic should be used by each student or team. Bu successive transfer of bacteria from one level of antibiotic they survived to the next higher level, it is possible to raise a strain of resistant bacteria and demonstrate a rapid evolutionary change.

Knowledge 4-6

CONCEPT #10 - All living things, including man, are continually evolving.

Teaching Activities:

Investigate the use of insect sprays on commercial crops and the types and quantities used from year to year. (Where possible, canning company personnel may be able to serve as a resource person along with county agents and university extension personnel) Do these methods of insect control change because of the buildup of resistant strains?

Comprehension 7-9

CONCEPT #10 - All living things, including man, are continually evolving.

Teaching Activities:

Investigate man-controlled changes, such as the development of hybrid seed corn. Compare the quality of hybridized corn ears to that of self-pollinated ears. Note differences.

Analysis 7-9

CONCEPT #10 - All living things, including man, are continually evolving.

Teaching Activities:

Investigate the changes which have occured in the height and weight of man during the past 50 years. Analyze and graph data from the U. S. Army on the physical characteristics of inductees.

Evaluation 7-12

CONCEPT #10 - All living things, including man, are continually evolving.

Teaching Activities:

To demonstrate how physical characteristics or variations effect a species evolution, use one dozen ping-pong balls with some dented and others not. (The dents represent physical variations of the species.) Place the dozen balls at the top of an incline (5°- 10°). Some of the balls will roll to the bottom of the incline, others should be at various locations on the incline. Assume that those that roll to the bottom are subjected to a predator and are destroyed, the species will eventually evolve into specie that will have the physical characteristics of the dented ping-pong ball. (The predator could be at any point on the incline, possibly giving rise to two varieties or species.)

Knowledge 7-9

CONCEPT #10 - All living things, including man, are continually evolving.

Teaching Activities:

Investigate the evolutionary changes which have occured through the ages to some existing species, such as the horse, whale, etc.

CONCEPT #11

Even over a long period of time, environments may change at a faster rate than organisms can adapt to them.

The rate of evolutionary change has varied markedly among various species. The brachiopod Lingula, a kind of shellfish, is almost exactly the same today as it was 500 million years ago. More typical, however, is the evolution of the horse which can be traced back through fossilized remains of nearly all the intermediate stages, about 45 million years, to the Eohippus. He was a four-toed, fox sized animal of the western United States. During this time, eight or nine distinct genera evolved, which means about five million years per genus. Each succeeding genus could be expected to show differences somewhat greater than those characteristics which distinguish the horse from the zebra - both species of the same genus.

Man has evolved even more rapidly. The oldest recognizable subhuman remains are only about two-million years old. And modern man, homo sapiens, has been here only about 100 thousand years.

A long standing question has been...Why have there been periods of 100 million years of biological stability, that is farily uniform species composition - then in a relatively short period of two or three million years, mass extinction of many species. This has usually been attributed to changes in world climate. But this answer does not explain the relative species stability over the past few million years, during which time the earth has become much cooler. It can also be argued that as the earth cools or warms, animals would migrate south or north to compensate.

Recently the biological shifts have been attributed to oxygen shifts in the atmosphere. During high oxygen periods, (2-3 times as much as now), large animals such as dinasaurs would have had the necessary oxygen to supply the required energy. High volcanic activity removed much of the oxygen in oxides and water. There were periods when there was only a small fraction of todays 21% oxygen in the atmosphere. This would have made it impossible for very large animals to survive, and they would have disappeared.

Analysis 7-9

CONCEPT #11 - Even over a long period of time, environments may change at a faster rate than organisms can adapt to them.

Teaching Activities:

The rather indiscriminate uses of chemicals such as DDT have caused ecologists to feel that many wildlife species such as the bald eagle may become extinct because of intake of these chemicals in their bodies. As a research project, have students investigate (using appropriate reference materials), analyze this problem, and identify those facts that tend to support or reject the ecologists' viewpoint.

Evaluation 10-12

CONCEPT #11 - Even over a long period of time, environments may change at a faster rate than organisms can adapt to them.

Teaching Activities:

In areas where pond or field succession are in evidence, determine which types of organisms have been replaced, or are being replaced, by new species. In ponds, one may look for the disappearance of floating vegetation types, and the increase of emergent vegetation types as the pond becomes shallow. Comparison of ponds in various stages of succession would be ideal. In woods areas, have students search for species which are not reproducing. Example - open grown bur oak with spreading branches may be surrounded by tall, straight, red oak trees, with new red oak trees in abundance while no sign of the bur oak may be found.

Synthesis 4-6

CONCEPT #11 - Even over a long period of time, environments may change at a faster rate than organisms can adapt to them.

Teaching Activities:

Secure two aquariums of equal size. Equip one with an aerator... do not provide an aerator for the second aquarium. Put an equal number of fish in each aquarium, observe the differences in reproduction, and placement of fish in the two aquariums (fish should congregate toward the top of the water because of higher oxygen content). After studying the aquarium for an extended time, have students propose what kind of adaptation would the fish in the non-aerated aquarium have to undergo if they were to live in the lower oxygen content water.

Comprehension 7-9

CONCEPT #11 - Even over a long period of time, environments may change at a faster rate than organisms can adapt to them.

Teaching Activities:

After discussing evolutionary changes that have enabled animals or plants to survive when their environment has changed, have students select at least three animals or plants and name at least two adaptations that have allowed that species to survive. Example - Duck, webbed feet, water resistant feathers -- Cactus, thorns, thick skin.

CONCEPT #12

In any environment, one component like: space, water, air, or food may become a limiting factor.

Limitation of one factor will affect different organisms unequally; for example, situations too dry to support the growth of trees may support a vigorous stand of prairie grasses and flowers. On the other hand, in more moist areas where trees grow, limited sunshine may exclude prairie species and favor shade adapted forest shrubs.

Man is no less subject to limiting environmental factors. The population explosion unchecked will produce critical shortages of food, space, potable water, breathable air.

John Wesley Powell surveyed arid and semi-arid lands of the west, published 1879 report including recommendation for wise land development procedures. He felt these should be different than patterns established in east, because his studies of vegetation, topography, climate indicated that water was the limiting factor in the western lands. His advice was ignored by the government; lands were opened to settlers in usual manner; severe dust storms resulted. Failure to take into consideration the ecological significance of a limiting factor thus resulted in disaster.

Knowledge - K-3

CONCEPT #12 - In any environment, one component like: space, water, air, or food, may become a limiting factor.

Teaching Activities:

In areas where irrigation is practiced, a field trip to a irrigated field of corn or other crop can be used to illustrate the dependence of plants on water. This is especially evident where a circular boom irrigation system is in use. The corners of the field do not receive water and crops are normally very stunted.

Application K-3

CONCEPT #12 - In any environment, one component like: space, water, air, or food, may become a limiting factor.

Teaching Activities:

Slice tops from two carrots. Place one in a glass with water. Place the other carrot in a glass with no water. As a control, have the students identify the relationship of water to the two carrots and compare what might be the affect of animals placed in similar situations.

Comprehension 4-6

CONCEPT #12 - In any environment, one component like: space, water, air, or food, may become a limiting factor.

Teaching Activities:

Use an increment bore to take core sample from two trees of similar age - one growing in a sparsely populated area, another in a densely populated area. Compare annual tree growth by years.

Have students determine why the growth rings and size of trees vary.

Application 4-6

CONCEPT #12 - In any environment, one component like: space, water, air, or food, may become a limiting factor.

Teaching Activities:

This activity is related to Activity # Have students design another experiment either at home or in the laboratory using a different environmental factor (light, space, moisture, air or food) which will affect the activity of a plant or animal.

Analysis 4-6

CONCEPT #12 - In any environment, one component like: space, water, air, or food, may become a limiting factor.

Teaching Activities:

To show that the temperature of the environment determines the activities and survival of living things, collect an ant colony. In the classroom, set up four colonies in quart jars covered with black paper. Make sure that each colony has adequate soil, moisture, food (sugar cubes, leaves, crumbs, etc.) After one week, put one colony in a hot place (an incubator or box with a light bulb), one at room temperature, one in a refrigerator, and one in a freezer. Observe each colony for one week. Infer, from the evidence, the effects of temperature on the survival of the colony.

Comprehension 7-9

CONCEPT #12 - In any environment, one component like: space, water, air, or food, may become a limiting factor.

Teaching Activities:

In four soil containers (flats - approximately 18" square), place at a depth of at least 2", fertile soil. Number flats from 1-4. In flat #1, plant radish seeds one inch apart using a grid. In flat #2, plant tomato seeds spaced in the same manner. In flat #3 alternate radish and tomato seeds again using the grid. On flat #4 alternate radish seeds and tomato seeds using a spacing of 1/2" between seeds. Water all flats in the same manner and keep in the same temperature and light conditions. At the end of a two or three-week period, collect and weigh plants from each flat. By interpreting weight data, students should be able to determine the implications of space requirements of growing plants.

Synthesis 7-9

CONCEPT #12 - In any environment, one component like: space, water, air, or food, may become a limiting factor.

Teaching Activities:

Approximately one-half of the air pollution caused by burning fossil fuel is from the automobile. Have students propose ways that automobile exhaust can be controlled and still fill our transportation needs.

Analysis 7-9 10-12

CONCEPT #12 - In any environment, one component like: space, water, air, or food, may become a limiting factor.

Teaching Activities:

On the reverse side of this card are estimates of water use projected to 1980. Estimates are based on the assumption that our population will be approximately 230.8 million and industrial growth will double. Have students graph the estimated and projected water use for the period 1900-1980. On the basis of the graph, have students infer about the rate at which water use has increased and is expected to increase in the next few years. Students can compare and account for the differences between past and projected water use.

WATER USES PROJECTED TO 1980

IN AVERAGE BILLIONS OF GALLONS PER DAY

YEAR	TOTAL WATER USE		IRRIGATION[1]		PUBLIC WATER UTILITIES		SELF-SUPPLIED USES					
							Rural domestic[2]		Industrial and miscellaneous[3]		Steam electric utilities	
	Total	Ground	Total	Ground	Total	Ground	Total	Ground	Total	Ground	Total	Ground
1900....	40.19	7.28	20.19	2.22	3.00	1.05	2.00	1.60	10.00	2.40	5.00	0.01
1910....	66.44	11.68	39.04	5.27	4.70	1.49	2.20	1.76	14.00	3.15	6.50	0.01
1920....	91.54	15.78	55.94	8.17	6.00	1.79	2.40	1.94	18.00	3.87	9.20	0.01
1930....	110.50	18.18	60.20	9.09	8.00	2.30	2.90	2.40	21.00	4.37	18.40	0.02
1940....	136.43	22.56	71.03	11.22	10.10	2.82	3.10	2.64	29.00	5.86	23.20	0.02
1945....	170.46	28.33	83.06	14.12	12.00	3.28	3.20	2.78	41.00	8.12	31.20	0.03
1950....	202.70	35.19	100.00	19.80	14.10	3.78	4.60	4.09	38.10	7.47	45.90	0.05
1955....	263.80	47.79	116.30	29.08	16.30	4.27	5.40	4.91	49.20	9.45	76.60	0.08
1960....	322.90	58.17	135.00	35.24	22.00	5.68	6.00	5.58	61.20	11.57	98.70	0.10
1963....	352.18	63.04	142.86	38.18	23.80	6.04	6.30	5.91	68.40	12.80	110.82	0.11
1965....	371.70	66.30	148.10	40.14	25.00	6.28	6.50	6.14	73.20	13.62	118.90	0.12
1970....	411.20	73.27	159.00	44.20	27.00	6.64	6.90	6.56	86.00	15.74	132.30	0.13
1975....	449.70	79.37	169.70	47.52	29.80	7.15	7.20	6.85	98.40	17.71	144.60	0.14
1980....	494.10	84.04	178.00	50.02	32.00	7.36	7.40	7.04	115.00	20.36	161.70	0.16

[1] Total take, including delivery losses but not including reservoir evaporation.

[2] Rural farm and nonfarm household and garden use, and water for farm stock and dairies.

[3] Manufacturing and mineral industries, rural commercial industries, air conditioning, resorts, hotels, motels, military and other State and Federal agencies, and other miscellaneous uses.

Source: United States Department of Commerce, Bureau of the Census, ***Statistical Abstracts of the United States***, 86th ed., 1965, p. 173.

CONCEPT #13

Succession is the gradual and continuous replacement of one kind of plant or animal community by another, characterized by gradual changes in species composition.

Primary succession takes place where an area is devoid of organisms, or which has not been changed physically by organisms. Example; bare rock - lichens - mosses - ferns - flowering plants - the first stages gradually providing the organic soil needed for the later stages. Another example would start with wind-blown sand and end with a prairie community. Soil buildup takes centuries, yet by lack of husbandry we have allowed six of the nine inches of soil present at the time of colonization to be lost through erosion.

Secondary succession is most easily observed where a field once plowed is abandoned. Organic soil is already present. Here the stages observed might be: disturbed soil - annual weeds - perennial herbs - shrubs - pioneer trees - self maintaining climax forest.

Forests result only where climate is suitable. In dry areas the succession may end with perennial herbs; for example, prairie or desert communities. Man can and does affect succession: growing of food plants such as corn is an example of man keeping the succession at the annual weed stage. (Ecological weed definition: Plant needing (1) disturbed soil (2) plentiful sun (3) lack of competition.)

The Indians in southwest Wisconsin and elsewhere maintained by fire, a community known as an "oak opening" or oak savannah - large areas covered by prairie with a few widely spaced oak trees. (Similar savannah areas are found in Africa and South America, likewise maintained by fire.) The annual fires arrested the succession at the perennial herb and pioneer tree stages. Managing at less than the final successional stage or climax requires continual effort, e.g., lawn mowing, plowing and cultivating, annual fires.

Wetland succession is of particularly great interest. Possible stages may include: open lake - submerged and floating aquatics - cattails - sedges - shrub - swamp forest - mesic forest. The lake will tend to fill in over many years; hence a landscape with many lakes such as northern Wisconsin, is a relatively "new" landscape in geological time. Fertile lakes support abundant water plants. Succession is speeded up by activities of man which add nutrients to lake waters including discharge of storm sewers, industrial wastes, and effluent from sewage treatment plants. Runoff from farm fields, especially of manure spread on frozen ground and washed off by early spring rains, adds to the problem of overfertilization of lakes. Usual symptoms are excessive growth of water plants, especially algae, followed by die-off and decay of the algae which results in oxygen depletion, foul odors, sometimes fish kill. Treatment of symptoms by plant poisons fails to attack the causes of the problem and may further upset the ecological balance.

Analysis K-3

CONCEPT #13 - Succession is the gradual and continuous replacement of one kind of plant or animal community by another, characterized by gradual changes in species composition.

Teaching Activities:

Bring several shovels of soil in the classroom. Observe the soil for several weeks and record the different kinds of plant life that become evident.

Refer to Concept #12 and discuss what factors cause some plants to replace others in succession.

Comprehension 4-6

CONCEPT #13 - Succession is the gradual and continuous replacement of one kind of plant or animal community by another, characterized by gradual changes in species composition.

Teaching Activities:

Compare the plant life found at a new construction site with an area that was under construction several years ago. This might best be accomplished by taking students to road construction areas. In comparing the areas, students should be able to recognize the replacement of annual plants by perennial plants.

Refer to Concept #12 and discuss what factors cause some plants to replace others in succession.

Analysis 7-9

CONCEPT #13 - Succession is the gradual and continuous replacement of one kind of plant or animal community by another, characterized by gradual changes in species composition.

Teaching Activities:

In an area of the school ground that is relatively free of student traffic, dig up an area two-yards square. Have students keep records of the kinds of plants that appear in the dug up area. Comparisons can be made with another two-yard square area that is located nearby. If possible, records can be kept on this area for at least a two-year period. This activity should begin in the spring of the year.

Refer to Concept #12 and discuss what factors cause some plants to replace others in succession.

CONCEPT #13 - Succession is the gradual and continuous replacement of one kind of plant or animal community by another, characterized by gradual changes in species composition.

Teaching Activities:

From the school cafeteria, get three large jars at least one-gallon in size. In jar #1, place an assortment of twigs, dead leaves, and stones from a puddle or pond into about 2/3 gallon of sterilized pond water (sterilize by boiling for at least two minutes). In a second jar, use only 2/3 gallon of sterilized pond water. The final jar should contain a community consisting of an inch of fine gravel, two-quarts of unsterilized pond water and several organisms collected from the pond. The jars should be partially covered and placed in strong but not direct light. Have students examine jars daily for a week and then once a week for two months. The "cloudy water" or "scum" might be looked at with a microscope. Students should be able to distinguish between changes that occur in each of the jars.

Refer to Concept #12 and discuss what factors cause some plants to replace others in succession.

CONCEPT #13 - Succession is the gradual and continuous replacement of one kind of plant or animal community by another, characterized by gradual changes in species composition.

Teaching Activities:

Within easy walking or driving distance of most schools, field trips can be taken to observe examples of wetland and upland succession areas. Students should record the kinds or descriptions of the plants that are found in each stage of succession.

Refer to Concept #12 and discuss what factors cause some plants to replace others in succession.

CONCEPT 14

The interaction of environmental and biological factors determines the size and range of species and populations.

A species which has evolved in a particular environment will migrate until it confronts a barrier. Oceans and mountain ranges are effective barriers for land plants and animals. For example, in the Hawaiian Islands, the palm genus pritchardia has thirty species in eight islands, but no single species is found on any two islands. Some are even restricted to a single valley. Land masses are effective barriers for aquatic animals and plants of the Atlantic and Pacific Oceans. No doubt many organisms would do equally well (and probably some would "explode") on the opposite side of the Isthmus. The suggested plan of building a sea-level canal has caused a strong negative reaction from ecologists who realize that it is impossible to predict the long-term ecological consequences of random mixing of whole populations which have been independently evolving for millions of years. Note the devastating effect of the Welland Canal permitting the lamprey eel into the Great Lakes. With the obviously bad results from introducing many land species from one continent to another, can we expect a better result from mixing ocean species? Additionally, ecological barriers exist such as; temperature, moisture, dry or moist winds, soil, and competition from other species. Or, a species may depend on another species which is absent. For example, because the aconite plant is dependent wholly on the bumble bee for pollination, it is not found beyond the range of the bumble bee. Usually species with greater tolerance, that is, broader amplitudes, will have greater ranges.

Man himself is a relatively recent arrival in the Western Hemisphere. About thirty-five thousand years ago, the five races of homo sapiens had evolved in Europe, Africa, and Asia. These early men were not much different from man today. They had large brains, and a high degree of social organization, and tools and weapons which made them far superior as hunters. They spread to Australia and north over the Bering Straits to Alaska, then south to the tip of South America.

During these hundreds of centuries of migration, man had almost no effect on the distribution of other plants and animals because he was a simple hunter and food gather. He had no domestic plants or animals to bother bringing with him. This began to change when man moved out of the Stone Age, about 10,000 B.C., when he discovered planting crops for harvest and domesticating animals. When he moved about he took his crop seeds and domestic animals with him, extending their respective ranges.

Man began to extend the range of plants and animals in earnest in the 15th Century when far-reaching explorations of the globe started. Explorers brought back many strange kinds of plants and animals as well as the soil organisms and the plant and animal parasites and diseases. But even these efforts were small compared with modern mans' most recent accomplishments. By immigrat-

CONCEPT 14 (Cont.)

ing to North America, the European settlers have provided this continent, along with its crops and domestic animals, about 80% of its weeds...for example; ragweed, Canada thistle, quack grass, dandelions, as well as English sparrows, European starlings, German carp, house rat, Dutch elm disease, white pine blister, and thousands more.

Man has now reached the point where his environmental degradation and pollution, and resulting extermination of external organisms has surpassed the damage wrought by his casual and ignorant intermixing of organisms. It can reasonably be said man is now the greatest disrupter of the balance of nature.

Analysis 4-6

CONCEPT #14 - The interaction of environmental and biological factors determines the size and range of species and populations.

Teaching Activities:

Organize a field trip for the purpose of observing and investigating plant communities. The trip can begin in the school yard and extend to fields, woods, pond and boggy areas. In each of the communities, record the type (grass, shrub, etc.), size of plants that are present. Also list the environmental characteristics that are unique to each area. Upon return to the classroom, have students categorize the differences in the plants found in each community and identify environmental conditions that may have been responsible.

Comprehension K-3

CONCEPT #14 - The interaction of environmental and biological factors determines the size and range of species and populations.

Teaching Activities:

Earthworms have environmental and biological demands that must be met if they are to be present in the soil. Choose four different locations near the school ground. With a spade, dig an equal amount of soil from each area. Count the number of earthworms that are found in each sample. Compare each sample of soil and list its characteristics, i.e., sandy, little organic matter, dry, etc. Have students determine those soil characteristics or environmental factors that are present in the soil having the largest number of earthworms.

CONCEPT #14 - The interaction of environmental and biological factors determines the size and range of species and populations.

Teaching Activities:

In Wisconsin the deer population is quite interesting to study. Annual records of estimated populations in given areas are kept by Game Managers of the Wisconsin Department of Natural Resources. During the winter months when heavy snowfall has been experienced, if deer populations are high, food must be supplied if winter kill is to be prevented. This practice can upset natural population restraints. A debate can be organized to examine this subject "Resolved - The practice of providing food to deer during periods when natural food sources are inaccessible should be stopped".

CONCEPT #14 - The interaction of environmental and biological factors determines the size and range of species and populations.

Teaching Activities:

Environmental factors have caused some states to have a relatively low population density. Students, using appropriate reference material, can identify the five states that have low population density and define environmental factors that may be responsible.

CONCEPT #15

Biological systems are described as dynamic because the materials and energies involved are parts of continuous cycles: All life is dependent upon the energy transfers of green plants.

When man thinks of natural cycles, too often he thinks of things in nature, and removes himslef from that context, for example, outside the context of nature. When we ask, "What is nature?", we usually get a reply relating to that "something" out there in the woods, or the lakes. We might recognize that a nitrogen atom trapped by a blueberry plant in its leaf could be eaten by an insect - to a frog - to a snake - to a hawk. But when the hawk dies, the nitrogen atom could go to a scavenger beatle. When the beatle dies, decomposing bacteria could release the nitrogen atom to be returned to a blueberry which you or I might purchase in a market. When we die, the decomposing bacteria could release the nitrogen atom to a plant to be trapped in another leaf, to be eaten by another insect, etc., and so the nitrogen cycle goes.

Mans' participation in this particular cycle would have been much more typical ten-thousand years ago when he was a simple hunter and food gatherer - prior to farming. There are, however, still cultures today which do not practice agriculture. Nevertheless, man is just as much a part of these cycles as ever. He has simply substituted domestic crops and animals for wild plants and animals. He adds nitrogen fertilizers to a field of corn, then sprays the field with insecticides to kill the insects - then feeds the corn to his cows - then, either drinks the milk, or eats the cow.

Not only is nitrogen recycled in this way, but similarily are all of the thirty to forty elements required by living elements for growth. Cycling or reuse of the same minerals is the basis of life for the whole living world. An example of this is that the equivalent of all the world's (CO_2) is cycled through plants and animals about every seven-hundred years, and (O_2) about every seven-thousand years. Man is just as dependent on the oxygen which comes from plants (70% of the world's supply from ocean plants) as is the bumble bee which pollinates some of mans' plants which he eats.

What man mostly fails to realize is that with his recently achieved massive environmental influence, through his greatly increased numbers and technology, he can easily disrupt these all-important cycles (air and water pollution - rivers, lakes, oceans, estuaries - prairies and forests). A critical cycle disruption brought about by man is the phosphorous cycle. In most ecosystems, phosphorous is a limiting factor. But man, primarily through his use of detergents, has injected tremendous amounts of additional phosphorous into the sewage systems. In the U.S.A., 10 million pounds per year in 1900, and 250 million in 1960. The ecosystem simply breaks down with massive algae blooms, which in turn die, and the decomposing bacteria (which uses oxygen in respiration, but does not produce any in photosynthesis) multiply, depleting the oxygen supply in the water which in turn asphixiates fish and other aquatic animals.

CONCEPT #15, (Cont.)

The single source of energy which keeps these cycles operative is the sun. Leaves use about 2% (.5 to 3.5%) of the light striking their surfaces.

At each level upward in the food chain, from 80% or more of the sun's original energy input is lost (dispersed as body heat and respiration). Thus, when man eats a fish that ate a small fish that ate a shrimp that "grazed" on plankton, man has received a tiny percentage (about one-one thousandth) of the energy as opposed to his eating the plankton directly - but fish taste so much better! Will man preserve the option of being able to continue eating fish - or, will he increasingly short circuit, and disrupt dynamic natural cycles?

About three percent of visible light is absorbed by green plants and used in formation of carbon compounds from materials present in water, air, and earth. From these compounds, all living things are formed, and all life derives its energy. Loss of energy at each level - example: from producer - primary consumer - secondary consumer -- decomposer. Therefore, large quantity of green leaves necessary to support consumer levels.

Food chain, food web, food pyramid, are all useful metaphors to express certain aspects of energy transfer.

CONCEPT #15 - Biological systems are described as dynamic because the materials and energy involved are parts of continuous cycles: All life is dependent upon the energy transfers of green plants.

Teaching Activities:

Take children to a dairy farm. While there, have the farmer discuss the kinds of food that cows eat and where these foods come from. In the classroom, recall the food that the farmer fed the cows. Help the children see that each food originally came from plants. Discuss the foods which we get from cows. Explain the meaning of consumers to the children. (1st order consumer would eat plants directly, second order consumer would eat a food product produced by a 1st order consumer.)

At the next lunch break, have carrots or celery for children to eat. Ask which order of consumer they are when eating a carrot. Then have children drink their milk. Ask which order of consumer they are now. Have pictures of various foods and have children determine whether they would be first or second order consumers when eating each.

CONCEPT #15 - Biological systems are described as dynamic because the materials and energy involved are parts of continuous cycles: All life is dependent upon the energy transfers of green plants.

Teaching Activities:

Using the food from the menu that the school lunch program serves for a one-week period, have student trace the food back to a plant source. Examples -- Meat - Store - Packing Plant - Farmer - Pig - Corn - Plant - Apple - tree - Bread - Store - Baker - Miller - Wheat - Plant.

CONCEPT #15 - Biological systems are described as dynamic because the materials and energy involved are parts of continuous cycles: All life is dependent upon the energy transfers of green plants.

Teaching Activities:

- Get a one-gallon salad dressing or pickle jar from the cafeteria or a restaurant. Make a stand on which the jar may be placed on its side. Put a half-inch layer of charcoal in the bottom, followed by sand and topped with 1½ inches of woodland topsoil. On this foundation, plant a few small woodland plants such as mosses, ferns and the like. Moisten but do not saturate and then close the lid. For best results leave the jar open for a few days before sealing it.

When it appears to be balanced with visible plant life, insert a few small animals such as toad and snail, and close the lid tightly. If more than one terrarium is prepared, have one without animals, one with a few and one with a great many.

Keep terrarium in a diffused light.

(Over)

Discussion areas might include; When terrarium is sealed, how are plants supplied oxygen? Water? Carbon dioxide? (When terrarium is sealed, condensation of transpired water occurs in inside of glass. This is the hydrological cycle. Oxygen and carbon dioxide are cycled similarly although not visible.) What happends to these cycles when animals are introduced?

CONCEPT #15 - Biological systems are described as dynamic because the materials and energy involved are parts of continuous cycles: All life is dependent upon the energy transfers of green plants.

Teaching Activities:

Have the children study specimens (alive or pressed, pictures, and/or drawings of the feet of many different kinds of birds and mammals. Do the same with the mouth parts (beaks or teeth). What does the structure (shape, size, location, special features) suggest about the kind of use each part is adapted for? For example, heavy claws (hawk) are adapted for catching prey, light claws (sparrow) for perching, webbed feet (duck) for swimming. Hooked beaks (hawk) are adapted for tearing prey; short, thick, strong beaks (sparrow) for cracking seeds. Broad shovel-like beaks (duck) for scooping and straining.

Ask questions like, "What might be the food relationships between these various kinds of animals?" (Who eats who?) "How many smaller organisms (mice) might a larger organism (hawk) have to eat to maintain his body?" "How many seeds might a mouse have to eat to maintain his body?" Develop a pyramid of numbers.

CONCEPT #15 - Biological systems are described as dynamic because the materials and energy involved are parts of continuous cycles: All life is dependent upon the energy transfers of green plants.

Teaching Activities:

Obtain two flower pots of equal size. Measure and weigh so that each pot is the same, with the same type and amount placed in each. Place two bean seeds in one and no seeds at all in the other pot. (Weigh the bean seed)

Place the two pots along side of each other on a window-sill and water each with the same amount. After the two pots have been treated in the same way for an extended time, weigh each. The difference in weight is due to the presence of the plant in one and no plant in the other. Now remove the plant carefully from the pot in which it grew and carefully shake out all the soil from the roots back into the pot. (You may want to use a soft hair brush) Now weigh the plants. Students through interpretation of data should conclude that plants are produced from the combination of a few minerals from the soil, and gases of the air plus water and sunshine in a process called photosynthesis.

CONCEPT #16

Green plants are the basic source of food, clothing, shelter, and energy in most societies.

Only in a green plant is the sun's energy captured, to be stored, converted, and used by a series of living things. Man has not been able to duplicate in his laboratories, the remarkable process of photosynthesis on which all life depends.

Von Helmont's classic experiment demonstrating that the increased mass of a growing tree could not be accounted by by loss of materials from the soil in which it grew, is an excellent illustration of the role of photosynthesis in producing material (wood) useful to man for housing, fuel, clothing (rayon), paper, etc.

At each successively higher level on an energy pyramid, the organic mass is reduced due to metabolic and energy transfer losses occurring at each exchange.

Importance of control of primary consumers by predation, etc., to prevent over consumption of plant cover which must be maintained in sufficient quantity to support the higher levels.

As food shortages become more acute with expanding populations, man may not be able to afford the luxury of the waste of energy involved - for example, in converting alfalfa to beef. Man may have to become mainly a primary consumer (plant eater).

Analysis 4-6

CONCEPT #16 - Green plants are the basic source of food, clothing, shelter, and energy in most societies.

Teaching Activities:

Choose items in the classroom at random and have students trace (if possible) back to green plants. Example - plastic which can be traced to cellulose which comes from plants. In some instances, students may have to research constituants of items.

Comprehension K-3

CONCEPT #16 - Green plants are the basic source of food, clothing, shelter, and energy.

Teaching Activities:

Have students bring magazines from home. (Ladies magazines will be best) Develop a bulletin board with picture examples of food from plants, clothing from plants, shelter from plants, and energy from plants. (When possible, also illustrate source of plants.) Through these activities, students should be able to comprehend the value of plants in our society.

Evaluation 7-9

CONCEPT #16 - Green plants are the basic source of food, clothing, shelter, and energy in most societies.

Teaching Activities:

Divide with a line, a blank piece of paper. Have students list in the right hand column, those items in their homes that can be traced back to plants. On the left hand column have them list those items that do not have a plant source. Ask the question, "How would your life differ if there were no plants?" (Exclude green plants as a source of food when doing this exercise.)

CONCEPT #18

All resources are vulnerable to depletion in quantity, quality, or both.

This statement is especially true today because the whole momentum of civilization has been to "develop" our resources. The Romans wanted more and better boats, and better aquaducts. The early American settlers wanted more and better guns and wagons. Today, Americans want more and better cars, T.V. sets, homes, power boats, etc. As demands developed, industry met them with products and services. With a multi billion acre wilderness to conquer, little or no thought was given to resource management - quite the contrary! A tremendous amount of time, research and money has been devoted to faster and cheaper ways of getting out the timber, coal, iron, oil, fish, beef, etc. In other words, our tools of exploitation have been superbly developed over a long period, along with our institutions to operate these tools. Meanwhile, the conservationists tools and institutions are young, inexperienced, and very imperfect and, therefore, largely ineffective.

Because of the above patter of development, we find that two resources, just a few years ago, were not even considered a resource, but universal quantities - are now limiting resources in many areas today - clean air and clean water. The by-product of industry meeting wants (not necessarily needs) of society, along with agricultural and municipal by-products, are placing extreme burdens on our air and water. And the burden increases daily.

In the natural realm, it is rarely recognized that because many species can not be preserved individually because of their interaction with, and dependence on, other species and their whole environment. So, whole ecosystems (clean lakes with the inflow waters, prairies, forests, marshes, marine estuaries, etc.) must be preserved to preserve the species involved. Needless to say, ecosystems as such have been severely diminished both in quantity and quality throughout the world. Just consider for a moment, a 50 mile radius around your school. How does the area differ today from 100 years ago? Are the woodlots that we still see really as they were 100 years ago? Or, has there been a lot of cutting and removing of man-preferred species, altering the original composition and age distribution? Has there been grazing in the woodlot with severe damage or elimination of the hundreds of species of herbaceous plants along with all kinds of insects, mammals, and a myriad of other groups of organisms requiring an integrated ecosystem - not simply a stand of trees?

Similarly, our record of soil use and abuse is no brighter. Dust bowls of the Thirties, plus sheet and gully erosion. Soil has been, and still is being depleted both in quantity and quality.

The important thing is that, as resource managers, we look at the whole ecosystem, the whole context, or, as we so often hear, "the big picture". The problem is that man has usually sidled up to that part of the "picture" that he fancied, without first taking an overview and attempting to understand what he saw. Unfortunately, when we do look, we do not usually see things as they are, but as we are.

CONCEPT 18 - All resources are vulnerable to depletion in quantity quality, or both.

Teaching Activities:

Discuss pollution in the classroom - include a definition for pollution. A definition you might use is any substance or material in water that makes it unfit for its intended use. Then take students on a fieldtrip to a local stream or lake and identify pollutants that would make the water unfit for human consumption.

After the field trip, students can determine three measures that, if enforced, would reduce pollution in the stream or river.

CONCEPT #18 - All resources are vulnerable to depletion in quantity, quality, or both.

Teaching Activities:

What is quality environment to a ten-year old? Discuss and develop a list of what has or could deplete such an environment.

CONCEPT #18 - All resources are vulnerable to depletion in quantity, quality, or both.

Teaching Activities:

During a rain, have students collect water samples from various areas around the school. Example - roof runoff, from a water puddle, from lawn run off, etc. Collect at least two samples, one early in the rain, and one rather late in the rain. (Make sure collection jars are clear.)

Perform the following activities:

(a) Shine a slide projector beam through the jar. Determine the ability for light to pass through water.

(b) Evaporate and observe residues of various samples. Weigh samples.

(c) Filter and observe residue. Weigh residue.

(d) Clean water by using various kinds of filters.

Evaluation 10-12

CONCEPT #18 - All resources are vulnerable to depletion in quantity, quality, or both.

Teaching Activities:

Take students on a field trip to local sewage disposal system. Observe the process that sewage is subjected to. Note the problem of what is left and how it is disposed of. If sewage plant is located on a stream, observe water above and below the sewage plant. If a dissolved oxygen test kit is available, measure oxygen content of water.

In the classroom, have student propose what must be done locally to eliminate pollution by sewage plants. (Make sure economic problems are included.)

Synthesis 7-9

CONCEPT #18 - All resources are vulnerable to depletion in quantity, quality, or both.

Teaching Activities:

Provide students with statistics concerning the quantity remaining of a mineral resource, and the average annual utilization of that resource. Then have students calculate the number of years before depletion of the resource occurs.

Then have students propose what changes society will have to make in the future without that resource. (Petroleum would be an excellent resource to use for this study.)

Comprehension 7-9

CONCEPT #18 - All resources are vulnerable to depletion in quantity, quality, or both.

Teaching Activities:

After discussion of endangered wildlife species, and using all appropriate reference materials, have students write an essay about an endangered wildlife species. This essay could include information about; former numbers, reasons for the species endangerment, current numbers, current programs to protect the species.

CONCEPT #19

Natural resources are important biologically, economically and aesthetically.

Many natural resources are not only important to man, but critical to his survival; fertile soil, clean water and air (non-toxic to plants or animals), and sunshine for photosynthesis. All of these natural resources help provide man with food. We also need to preserve plant and animal diversity, not only as genetic resources for future use, but to minimize rampant disease. There are many diseases and insects which can attack all the plants of a cornfield, but there is no disease or insect which can attack all the hundreds of species of the prairie or the forest which preceded that cornfield. As man simultaneously increases his corn (wheat, rice, etc.) acreage, and his chemical assault on his agricultural pests, the more pesticide resistant pests he will generate over larger acreages of monoculture. So, the more dependent he will become on stronger and different kinds of pesticides. He will use these chemicals in his own environment without really knowing very well the ultimate results of the actions and interactions of these chemicals, on chemical combinations, on other organisms in treated fields, or on organisms which migrate in and out of these fields. What about the final results downstream or downwind?

Mans' preoccupation with his personal and immediate wants discourage his considering the needs of others, especially at a later date, or at another place (downwind or downstream), let alone a different continent. This attitude must change if man is to survive on a world of quality.

Natural resources, as natural ecosystems, are biologically important for research into how organisms function in their natural interactions, nutrient cycling and energy flow. A natural ecosystem, to a field scientist, provides information on past, present, and even many future phenomena, that can be obtained only from a natural ecosystem. Such an ecosystem is as important to the field scientist as books are to an historian. The difference is that books can be readily and accurately reproduced - natural ecosystems cannot!

The economic advantage of abundant natural resources is well demonstrated by this century's rapid rise as a world power and its ability to accumulate capital, which is reflected by its extensive foreign investments and high material standard of living. But it is the values, attitudes, and goals of the people of a nation that determine how, when, and to what ultimate purpose their technology and natural resources will be devoted.

As technolgoy has advanced and resources have been utilized, and income increased, Americans have increased their proportion of leisure time dramatically. Much of this new free time is now spent in fishing, boating, swimming, hunting, and hiking. But what use is there in pursuing these leisure time activities if

CONCEPT #19 (Cont.)

the streams are dead, the shores smell, the lakes are green, and the sounds of truck tires on adjacent highways fill the woods? We hear that people take to the woods and lakes "to get away from it all"! Unless areas are protected from technological invasion, "it all" is going to be right out there in the wilderness, leaving no place to get away to.

In the same fashion, we are conditioned to prefer certain foods, clothes, music, etc., we might do well to emphasize, at an early age, the pleasures and real profits from the arts, natural aesthetics, and development of an inner resource. In so doing, we could de-emphasize those rigorous activities which can cause such great and permanent damage to our natural resources. And, who can tell what greater goals we may achieve from fuller development of our intellectual resources which lie so dormant and so untapped in so many of us.

CONCEPT #19 - Natural resources are important biologically, economically, and aesthetically.

Teaching Activities:

Have children bring in slides or magazine pictures of places they would enjoy being. Have class react to each - how many react favorably to each?

Debate merits and demerits of where a highway should go given several alternatives.

CONCEPT #19 - Natural resources are important biologically, economically and aesthetically.

Teaching Activities:

Through discussion, fieldtrips, and visual aides, provide students with a background of a particular resource (i.e., forests, water, etc.) and its value. Develop the meaning of the terms; biological, aesthetic, and economic. Then have the students develop lists of the ways that the resource has biological value, aesthetic value and economic value.

Example -

(a) Campers enjoy the pine trees at a camping ground (aesthetic).

(b) A farmer markets ten cords of pulp wood (economic).

(c) The forest provides a habitat for many species of animals (biological).

Evaluation 10-12

CONCEPT #19 - Natural resources are important biologically, economically, and aesthetically.

Teaching Activities:

Simulation game - value decisions where interests conflict. Example - a man-made lake is planned in the local area or, a new power plant is being constructed.

Analysis 7-9

CONCEPT #19 - Natural resources are important biologically, economically, and aesthetically.

Teaching Activities:

Have each child think of a place he likes to be because he feels good there; then analyze what it is about that place that affects him positively. Capitalize on different opinions to show that various desires may conflict and that we need to have choices for all.

Comprehension 7-9

CONCEPT #19 - Natural resources are important biologically, economically, and aesthetically.

Teaching Activities:

Take a natural resource, i.e., a tree, a lake, - discuss how it is important biologically (tree - insect food, bird habitat, etc.), economically (lumber, extra value of wooded lots, etc.), aesthetically (shape, shade, fall color, etc.).

CONCEPT #20

Mans' ability to reason enables him to change his environment.

Man first changed his environment when he built shelters from the weather. The changes, however, were only small and temporary. Greater and more permanent changes occurred when man began farming. He had discovered that he could plant seeds and harvest a crop and breed and raise animals. In irrigating, he rearranged natural stream flow and deposition of silt. His heavy concentration of domestic animals increased the grazing pressure on local fields. He also burned and cleared land to provide more farming acreage. The increased farm production made it possible for cities to develop because man no longer had to stay on the move in search of wild plants and animals.

As the human population and the size of cities, and the technology pool grew, so did mans' impact on his environment. His environmental changes were almost entirely by-products of other activities - erosion from farming, municipal sewage (waste pollution), smoke and oxides of carbon and sulfer from burning coal and later oil (air pollution), and recently by-products from manufacturing which are injecting a whole array of foreign substances into the environment, with unknown consequences.

A major intentional change in the environment is damming of rivers for power generation and flood control. But such dams are only temporary as silt is deposited above the dam. Probably the greatest intentional change is in the biological portion of the environment with our already extensive and ever-increasing use of agricultural chemicals, i.e., fertilizers and pesticides. He is trying to manage the farmlands, which has raised many questions regarding long-term consequences to the land, water, and other plants and animals including man himself.

The most recent kind of pollution is thermal - from nuclear power plants, utilities, and some other manufacturing sources. Waste heat is dissipated into water bodies raising their temperatures. This can increase algae growth and throw the life cycles of aquatic animals out of phase in relation to processes and organisms on land on which the aquatic animals might depend. For example, a premature fish hatch which depends on a particular insect hatch for food.

In short, as mans' energy sources have increased (wood, coal, water, power, oil, nuclear) along with his knowledge of how to harness them, his ability to alter the environment has similarly increased.

There is no need for man to be a puppet controlled by the whims of natural forces. But man must realize his part in the natural scheme of things, and that he cannot be sole producer and director of the whole show. His special technological applications have got be be based on sound ecological principles.

CONCEPT #20 (Cont.)

Reason provided knowhow for clothing, shelter, etc., enabling man to extend his range well beyond the climate which nurtured human evolution. In a sense, man enveloped his body with his required environment from the first crude shelters, to the air-conditioned buildings which provide optimum comfort in any area of the world today.

Later, mans' reason allowed development of complex powerful tools which have altered the face of the earth - agricultural tools which destroyed thousands of acres of complex diverse natural communities and replaced them with acres growing single species (and sometimes with examples of uncontrolled erosion). Irrigation changed desert into cropland. Vast acreages of marshland were drained (over 2/3 of Dane County's original marshlands have been drained.

Construction tools which can literally move mountains and fill valleys - paving which covers increasing percentages of city land decreases ground water supplies, increases erosion from run-off, even changes the very climate of our large cities.

Industrial tools which provide man with ever increasing comforts and gadgets, and in the process have changed the waters of the land and the very air we breathe.

Transportation tools which whisk man wherever he wishes to to - sometimes conveniently and comfortably, but always leaving a trail of mixed gases and solid particles which then become part of his environment - often with risk to his comfort, health, and even survival.

All these tools were developed by means of reason - reason directed toward problem solving of one kind or another i.e., more food, better shelter, faster travel. It is vitally important that the same concerted effort be applied to the problem of maintaining an environment not only habitable, but worth inhabiting. With enough incentive, mans' reason could provide solutions to the problems that threaten to destroy the environment of which he is part.

Application 4-6

CONCEPT #20 - Mans' ability to reason enables him to change his environment.

Teaching Activities:

Study local industry which changes or pollutes environment, considering how it changes the environment. (Chemicals in water? Air pollution? Noise?)

Consider conflicts involved in improving situation.

Comprehension 4-6

CONCEPT #20 - Mans' ability to reason enables him to change his environment.

Teaching Activities:

Choose a controversial local action that drastically changes environment. Interview people with opposing points of view.

- Location of nuclear power plant
- Creation of Lake Redstone
- Opening of housing development in area of good farmland

Have students determine what motives might underlie the points of view expressed by those interviewed.

Analysis K-3

CONCEPT #20 - Mans' ability to reason enables him to change his environment.

Teaching Activities:

In the classroom, have students develop a list of the ways different animals change their environment; beaver damming a stream, termites burrowing into wood, browsing of deer, etc. After each way the animal changes his environment, list reasons why. This would include need for food and shelter basically. Now have students develop a list of the way man has changed his environment. After each indicate the reasons why. Economic factors will be evident in most regardless of the effect on man or the area. Christmas tree plantations, suburbia, farming, lake shore development, industrial development, etc.

Application 7-9

CONCEPT #20 - Mans' ability to reason enables him to change his environment.

Teaching Activities:

Take students on a field trip to a state conservation area. Determine what the Conservation Department is doing to the environment of the area to make it attractive to wildlife. (Usually arrangements can be made for the Game Manager to be present to talk to the group.) Discuss the various environmental characteristics that attract particular species of wildlife. Make certain that students understand that conservation measures are remedial, made necessary because of mans' past actions. (Example - reforestation)

Analysis 7-9

CONCEPT #20 - Mans' ability to reason enables him to change his environment.

Teaching Activities:

Show the students an area that is close to the school that has a potential for development as any of the following: residential, industrial, recreational, natural areas, etc. Have the students plan how they would develop the area given no restrictions. After students have developed a plan, each student can make a presentation to the class on the way he has developed the area. Other members of the class can evaluate the proposed plans in view of the change of the environment and environmental problems that would be created.

Analysis 7-9

CONCEPT #20 - Mans' ability to reason enables him to change his environment.

Teaching Activities:

Take the students to an area that is relatively untouched by man. (Underdeveloped lake shore, forest area, prairie area) Have them observe the characteristics of area; soil, vegetative growth, water (lake), esthetic beauty. Then take students to an area that has been altered by man (developed lake, plowed area, residential area). Observe same characteristics. Have students identify detrimental affects man has had on his environment because of his ability to reason. If it is not possible to take a field trip, pictures of various environments can be shown class with similar student responses.

Synthesis 10-12

CONCEPT #20 - Mans' ability to reason enables him to change his environment.

Teaching Activities:

Consider changes in school area since time school was built... how did decisions made then affect present neighborhood? What do they wish they had near the school now? What do they wish weren't nearby? (Air pollution? Nois? Pollution? More space?, etc.) What conflicts are involved in meeting these desires?

Synthesis 10-12

CONCEPT #20 - Mans' ability to reason enables him to change his environment.

Teaching Activities:

What decisions being made now will affect people here, 50 years (or some time interval) from now?

CONCEPT #21

Options available to future generations must not be foreclosed.

The Europeans immigrated to North America in search of a better life. With abundant natural resources - fish, wildlife, timber, productive soils, ample water, etc., America soon came to be known as the land of opportunity - precisely because almost unlimited options were open to achieve the "good life" if one were only industrious enough to pursue it.

During the slightly more than three centuries since the Pilgrims landed on Plymouth Rock, the people of this country have fought Indians, Mexicans, British, each other, and several external wars. All with the intention of hanging on to the land "...from sea to shining sea!" - and its immense productivity.

As time went by, gold, coal, and iron were mined, forests cropped, fish, fowl, and game harvested, the prairies plowed, rivers dammed - the whole thrust was called "development" by most and "exploitation" by a few. When a pattern of "progress" has emerged over centuries, peoples' attitudes and desires have become set and, unless overwhelming evidence is available which cries out for a change, the pattern will continue. By the time the overwhelming evidence is accepted, the environmental damage is usually irriversible.

The point is that with lightening use of non-renewable resources combined with a continuing rapid population increase, plus imposing rigorous agricultural controls on organisms with highly toxic agro-chemicals, plus annual conversion of over a million acres a year from woodlands and farmlands, to highways and building sites, plus the much talked about water and air pollution from all mans' activities - there is absolutely no question that we are foreclosing options to future generations.

We must state the limits of what our environment can produce on the one hand, and safely dispose of on the other. Then we must decide, within those limits, of the goals man seeks which are in fact achievable - then agree on how they are to be achieved. Difficult? Yes! Very possibly impossible! This is why it is absolutely mandatory to teach environmental concepts so that society can act in as sane and rational a manner as possible, and maximize the preservation of options for all generations yet to come.

It has been predicted that the peak of the fossil fuel (coal, oil, gas) will come before the end of this century. Atomic energy as a substitute would result in large scale problems of disposal of atomic wastes highly destructive to all living things - a problem which cannot be over exaggerated according to biologists. Energy may be an overwhelming shortage to future generations; efforts should be made to conserve fuel use now.

CONCEPT #21 (Cont.)

Mineral shortages loom in the future, yet scrap metal is buried in dumps with other refuse. A suggestion that metal wastes be separated and piled in special hills from which later generations could retrieve vital metals is worth considering. Techniques for saving in general must be developed.

Soil conservation will be critical. What right have we to continue to allow soil to be lost (at a rate of 1/3 gone) in less than 400 years?

Preservation of natural communities is vital - forests, marshlands, savannahs, prairies, etc., so that man can enjoy this heritage of his own past, study it, use it as a standard against which to measure his man-made communities, preserve the gene pool of life accumulated over countless centuries.

And, of course, it all comes back to the one basic action we must take to make sure that future generations will have options available - that is the control of the human population.

Comprehension 4-6

CONCEPT #21 - Options available to future generations must not be foreclosed.

Teaching Activities:

Through class discussion, discuss ways of conserving non-renewable resources. For example; the automobile and the mineral resources and air pollution problems. Discussion could include reusing minerals used in car manufacturing.

Analysis 4-6 7-9

CONCEPT #21 - Options available to future generations must not be foreclosed.

Teaching Activities:

Make a list of options in jeopardy in own city, county, and state, i.e., quality of Lake Superior, Lake Michigan, also areas affected by Project Sanguine, nuclear reactors, excellent farmland in counties such as Dane under suburban pressure. Have class find out how agro-chemicals can be a threat to future options.

Comprehension 7-9

CONCEPT #21 - Options available to future generations must not be foreclosed.

Teaching Activities:

Using current census information, determine the number of deaths that occurred in the United States during the year. Assume that all people who have died will be buried in a 6'x8' plot in a cemetary. Have students compute the amount of land taken out of production for the one-year period. Variations in terms of days, months, and years could be used. Similar kinds of exercises can be done with highway construction, city growth, etc.

Synthesis 7-9

CONCEPT #21 - Options available to future generations must not be foreclosed.

Teaching Activities:

Have class bring in pictures of already spoiled options, i.e., polluted lakes, residential areas (formerly good woodland or farmland), filled or drained marsh, noise pollution, slum or over-dense downtown area (destroys privacy). (Higher apartments in hi-rise buildings are most expensive because of value of cleaner air, better view, less noise, etc.), highways destroying farmland or wetland, etc.

Have students propose solutions to the spoiled natural resources so they will be available to future generations.

Synthesis 7-9

CONCEPT #21 - Options available to future generations must not be foreclosed.

Teaching Activities:

Find a cultivated field with a 5% slope (5' drop in 100') or more that has been under cultivation for some time. Dig a small hole deep enough to get below the topsoil layer. Then cut off a slice an inch or more thick along the verticle side of the hole. Lay this slice on the ground and study it. Note the depth of the top soil layer. Study the soil structure - how are particles held together? Are they tight and does the soil hold together in large lumps (clods)? - or is it crumbly like a cake?

Dig another hole in a nearby area that has not been plowed but has a similar slope. Take a similar slice of soil and compare it with first slice. Have students list the differences in the two slices of soil and determine reasons for the differences. What will be the effect upon future generations if good soil management practices are not followed.

Evaluation 10-12

CONCEPT #21 - Options available to future generations must not be foreclosed.

Teaching Activities:

Discuss pictures brought in by class of scenic areas, water recreation, hunting, etc., as to mans' capability of spoiling these with present technology and direction.

CONCEPT #22

Environmental management involves the application of knowledge from many different disciplines.

This is true simply because of the tremendous amount of knowledge man has accumulated recently in all disciplines. One person cannot possibly know all the pertinent information in his own discipline, let alone all environmental disciplines.

True, we do not have to go back very far historically to the time when one person could be an authority in practically all fields of science. After all, oxygen's existence was not known until about 200 years ago (1770). Genetics began at the turn of this century with the rediscovery of Mendel's classic experiments with inheritance in peas, first published in 1866. In fact, science in general gained its momentum and respectability in the 1800's, and really "took off" in the 1900's. It is estimated that our technological pool is now doubling every ten years. 90 percent of all the scientists trained since Aristotle's time are working today.

To see how far we have come in our technological capability in this century, we only have to look around us at skyscrapers, superhighways, jet planes, TV, heart transplants, earthmen on the moon, etc. These complex technological processes and entities have all been constructed by man, however. They represent cumulative effort over time and input from many disciplines. So, any one of us is not only impressed, but overwhelmed by the apparent majesty of it all. But mans' performance in manipulating those conditions and situations which he has not directly and intentionally created (differences in climate, vegetational patterns, topography, soils, water distribution, races of man, his languages, etc.) have been notably ineffective. In other words, perhaps man has been mesmerized by his own astounding recent accomplishments (relative to what he had achieved previously), and so lacks perspective of the vastly more intricate, comprehensive and complex accomplishments of nature's evolution or organisms, processes, and interactions.

A man's total immersion of his own discipline gives him a poor understanding of related fields, and hence a distorted perspective of the broad context. For example, the engineer knows a lot about engineering. But, when a highway is laid out, does it not disrupt stream flow and pond drainage (limnology), farm land (agriculture), local culture and heritage (history), natural research and wildlife refuges (ecology), etc.?

Engineers are no better equipped to make ecological or historical judgments than ecologist or historians are to make engineering decisions. Consequently, careful consideration should be given to all acts which affect our environment and all those disciplines consulted during planning and prior to acting.

We all share our natural environment so it is the responsibility of all of us to preserve it in a healthy state.

CONCEPT #22 (Cont.)

The late Professor Aldo Leopold made the above point well when he stated "Mechanized man, having rebuilt the landscape, is now rebuilding the waters". The sober citizen who would never submit hiw watch or his motor to amateur tamperings freely submits his lakes to drainings, fillings, dredgings, pollution, stabilizations, mosquito control, algae control, swimmer's itch control, and the planting of any fish able to swim. So also with rivers. We construct them with levees and dams, and then flush them with dredgings, channelizations, and floods and silt of bad farming.

"The willingness of the public to accept and pay for these contradictory tamperings with the natural order arises, I think, from at least three fallacies in thought. First, each of these tamperings is regarded as a separate project because it is carried out by a separate bureau or profession, and is expertly executed because its proponents are trained, each in his own narrow field. The public does not know that bureau and professions may cancel one another, and that expertness may cancel understanding. Second, any constructed mechanism is assumed to be superior to a natural one. Steel and concrete have wrought much good, therefore, anything built with them must be good. Third, we perceive organic behavior only in those organisms which we have built. We know that engines and governments are organisms; that tampering with a part may affect the whole. We do not yet know that this is true of soils and water.

"Thus, men too wise to tolerate hasty tinkering without political constitution, accept without a qualm, the most radical amendment to our biotic constitution."

The pesticide control problem is a good example - the agriculturalists' viewpoint that emphasizes the necessity of increased yield through use of chemicals, needs to be balanced with the wildlife management alarm over declining wildlife populations as a result of use of those same chemicals and the concern of the physiologist over the possible effects on man. (An example of not following this concept: The Wisconsin legislature will soon be considering a bill which would establish a pesticide control board and advisory council dominated by agricultural interests.)

Engineers build dams to control floods, yet ecologists who study causes of floods point to the importance of good vegetative cover in the watershed before floods can be controlled.

The government subsidizes irrigation or arrid lands, while paying other farmers to curtail production.

Analysis 4-6 7-9

CONCEPT #22 - Environmental management involves the application of knowledge from many different disciplines.

Teaching Activities:

(Junior High)

Given a list of:

- Artist
- Economist
- Lawyer
- Ecologist
- Engineer
- Sociologist
- Doctor
- Chemist
- Philosopher
- Agriculturalist
- Recreation Specialist
- (Class can add to this)

Show how some or all of these people can help solve such problems as:

Planning a new housing development
Selecting a solid waste disposal site for a large city
Solving a conflicting use controversy over a local body of water (involving perhaps a mining industry, recreation, sewage disposal)
Improving a watershed
Locating a highway

(For Younger Classes)

Class discussion of mosquito problem. What measures used to control?

(Over)

Who decides this? On what basis should a plan be worked out? (Chemicals effective against mosquitos may also kill helpful insects or enter food chains and kill animals higher on chain)

Knowledge 4-6

CONCEPT #22 - Environmental management involves the application of knowledge from many different disciplines.

Teaching Activities:

If Elm trees are growing near the school, walk around the neighborhood to observe the Dutch Elm disease problem.

Discuss with the student, the life cycle of the responsible insect and control measures utilized. Discuss ways of coping with the disease.

View the film, "Insects, How to Recognize Them" and the filmstrip, "Fungi - Our Non-Green Plants".

Evaluation 10-12

CONCEPT #22 - Environmental management involves the application of knowledge from many different disciplines.

Teaching Activities:

In the local community, have students make a survey of business, industries, residential, etc., that have been buildt without regard to environmental repercussions. Example - industries built in waterways, sewage disposal plants, residential areas on marshland. When survey has been completed, propose disciplines that could and should have been consulted prior to construction. (This would be done by organizing teams to make the surveys)

CONCEPT #23

Optimum environmental management is dependent upon a well-informed public.

One of the most important considerations for the success of any program which involves a number of people, is good communication. And, of course, the information communicated has to be sound. In a democracy, social issues are considered and acted upon only when enough people become concerned. And the social issue of good environmental management has terrific competition from other issues and/or programs such as space, Viet Nam, racism, medical, education, urban renewal, etc. But, if man continues to degrade his environment and multiply like lemmings, all other issues will be academic.

Anti-social (anti-environmental) behavior in a democracy is controlled by legislation - and legislation derives from the people. So, it is mandatory that the citizenry get the hard environmental facts. If these facts are adequately communicated, the incentives will be there to produce the requisite programs and legislation to insure improved environmental management.

All our technological knowhow, which could be helpful in environmental protection, is valueless unless applied. It will not be applied unless we have first-rate channels from the scientists to the people, including society's decision makers.

A well-informed public is needed to pass laws:

The priorities set by legislative bodies are largely determined by public pressure. Laws to protect the environment will be enacted only when the public outcry is sufficient. Effective enforcement of such laws once passed will be possible only if the public continues to be informed and vigilant.

A well-informed public is needed to encourage individual action.

From litter control to the broader idea of getting away from the acquisitive emphasis of our society. Important to develop willingness to get along with a little less convenience or comfort in the interest of conserving resources or preventing pollution.

A well-informed public is needed to encourage responsible conservation actions on the part of industry.

By indicating a willingness to pay a higher price if needed, to produce the product in the manner most conducive to environmental preservation.

Analysis 10-12

CONCEPT #23 - Optimum environmental management is dependent upon a well informed public.

Teaching Activities:

Organize the class into teams with an assignment for each team to interview at least fifteen people.

Have students develop a questionnaire to ascertain: (a) how well the interviewee recognizes himself as a consumer and polluter of the environment; (b) how well informed the interviewee is as to problems of environmental quality management. (Example: Have the person choose the most important issue facing us today from list of: inflation, Viet Nam, population, pollution, etc.)

By analyzing statistics revealed through the interviews, students can judge how well the local public is informed about critical environmental problems.

Knowledge K-3

CONCEPT #23 - Optimum environmental management is dependent upon a well informed public.

Teaching Activities:

Have student prepare a list of what family can do to reduce environmental impact:

No littering
Buy beverages in returnable bottles
Turn off lights (saves nonrenewable coal, oil or gas and reduces air pollution)
Conserve water
Limiting creature comforts
No trash burning
More walking, less auto use
Use mass transit system
Patronize businesses which show environmental awareness

Make posters with good data to illustrate above. Choose best for display in grocery stores, etc.

Comprehension 4-6

CONCEPT #23 - Optimum environmental management is dependent upon a well-informed public.

Teaching Activities:

Have students compose a letter to one of their legislators expressing an opinion related to one of the news articles. The letter should reflect the evidence gathered from the news or from other reference reading.

Comprehension 4-6

CONCEPT #23 - Optimum environmental management is dependent upon a well-informed public.

Teaching Activities:

Have students bring in advertisements from magazines or reports of TV commericals and discuss these in terms of the impact on the environment. The conspicuous consumption implicit in the ads creates demand for more environmental inroads. Example: Automobile styles, excessive power, planned obsolescence has terrific impact on consumption of steel, gasoline, etc. plus air pollution effects and demand for more highways. Ads creating appetitie for travel.

Application 4-6

CONCEPT #23 - Optimum environmental management is dependent upon a well-informed public.

Teaching Activities:

In your classroom, devote a portion of your bulletin board to current environmental problems. Students can keep bulletin board up to date. Weekly, or at a determined interval, have students select ways that the current major problems could be solved. For example, letter writing to legislator, newspapers, radio station, T.V., etc., industries.

CONCEPT #23 - Optimum environmental management is dependent upon a well-informed public.

Teaching Activities:

Using the following materials:

(a) test tube or similar container
(b) snails
(c) elodea sprig or similar water plant
(d) pond water
(e) means for melting wax (candle)
(f) cork stopper or lid

In test tube #1, place a sprig of elodea, in test tube #2, place a snail. In test tube #3, place a snail and a sprig of elodea. Pour equal amount of water in each container. With melted wax from the candle, seal the tops of the containers. Each test tube represents different environments that might exist. Students in the class will represent the public (uninformed), and will be asked to make decisions about that environment. For example #1, what will happen to life

(Over)

found in the test tubes at the end of one week? Two weeks? Three weeks? Students should respond in writing. At each of the intervals, students should check what they hypothosized would happen with what actually happened. An analogy to this, and decision made by a well-informed public, could be made - game management problem, city planning, etc.

Evaluation 10-12

CONCEPT #23 - Optimum environmental management is dependent upon a well-informed public.

Teaching Activities:

Because of some factor your community is now going to have over 100,000 visitors each year. This will probably have a beneficial affect upon the business community, but what are the environmental implications to be considered?

Have the students evaluate different solutions to the environmental problems that will prevail.

Application 7-9

CONCEPT #23 - Optimum environmental management is dependent upon a well-informed public.

Teaching Activities:

Evaluate the local community effort as to:

Solid waste disposal
Sewage disposal
Open space planning
Aesthetics
Community growth planning
Transportation

Class will develop "do's" and "don'ts" criteria under each and interview local decisionmakers. Discuss how a well-informed community could help in these areas. Discuss effective ways of communicating information to achieve desired viewpoints.

Synthesis 10-12

CONCEPT #23 - Optimum environmental management is dependent upon a well-informed public.

Teaching Activities:

Assume that an event is about to happen that will have a repercussion upon the environment, i.e., a man-made lake is to be built, a new highway is proposed.

Have students research either by interview or reference materials on how the public can best be informed on problems to be encountered if the event becomes a reality. Students can then propose a program that they would use to make the public aware.

Concept #24

Natural resources are unequally distributed over the Earth's surface:

A glance at maps from an atlas or encyclopedia shows just how unequally resources are distributed around the globe. Of special significance is the rainfall map. A comparison of the maps on distribution of rainfall and human population shows the high correlation between lack of rain and lack of people - which indicates mans' heavy dependence on water. Similarly, forests are restricted to good rainfall areas with the conifers mostly occupying the drier but cooler areas.

Crop production likewise restricted to areas of adequate moisture and warm (sugar cane) or temperate (sugar beet) climates. Soils are also closely related to rainfall, temperature and crop production.

Although air at sea level is quite uniform, even it thins out with altitude.

Such unequal resource distribution underscores the need for international trade to help balance the inequities.

No need to go farther than Wisconsin to observe this unequal distribution - productive soils derived from native deep soil prairies in the southern part, poorer sandy soils in central Wisconsin. Hundreds of recreational lakes in northern Wisconsin are now feeling the pressures as people in southern Wisconsin and Illinois (where such prime recreational facilities are lacking) flock northward for vacations.

Globally, the unequal distribution has meant wealth for countries with many varied resources - poverty for those less endowed. Where an important mineral resource needed by technological societies was found in less developed areas, this often has led to economic and political domination of the countries with the resource by the countries wanting the resource (oil, Mid-East -- tin, Boliva, etc.).

One-third of the world's coal supply is in the United States, about the same in USSR.

Comprehension 7-9

CONCEPT #24 - Natural resources are unequally distributed over the earth's surface.

Teaching Activities:

Have students list what countries produce what products. Discuss relationship between products and (1) per capita income, (2) world influence exerted by each country.

Why doesn't - Egypt export cheese?
- Holland export bananas?
- Chad or Peru export automobiles?
- Switzerland export fish?

Why does Japan export fish and automobiles?
U.S.A. export oranges and computers?
Canada export timber and fish?
Greece export olives?
Bali export hand carvings?

Comprehension 4-6

CONCEPT #24 - Natural resources are unequally distributed over the earth's surface.

Teaching Activities:

Make overlay maps of resources on a base world map. Shorter Oxford Economic Atlas of the World can be used. Be sure to emphasize water as number one resource. Note correlation between population distribution and available water.

Analysis 10-12

CONCEPT #24 - Natural resources are unequally distributed over the earth's surface.

Teaching Activities:

Have students review state, U. S. and world maps pertaining to climate, soils, mineral resources. Discussion should bring out the above concept after students have brainstormed this.

Concept #25

The management of nonrenewable resources involves using of all known methods to maximize benefits to the most people over time: Minerals are nonrenewable resources.

Two of the most serious mistakes in resource management committed by man have been, and still are:

(1) The destruction caused while exploiting the resources, for example, tailings dumped into water bodies from milling operations at mine sites, acid pollution from mining, extensive physical damage to whole plant and animal communities from strip mining and off-shore oil well leakage from drilling operations.

(2) A short-term cost benefit ratio. If it is profitable to extract now, so be it! Little, if any, thought is given to the plight of the people and land when the resource is exhausted. This attitude produced a host of ghost towns in the West.

To date, man has been able to get away with such behavior although environmental quality has suffered to an unnecessary extent (loss of fish, wildlife, aesthetics). Man has been able to discover new reserves of metals and fossil fuels faster than he has been able to consume them. No one suggests this can go on forever - to ignore that the landscape and the resources it harbors are finite is to ignore a simple methematical truth. But the exploiters express complete faith in mans' ingenuity. He will, they claim, keep developing substitute resources. Perhaps steel can be replace by plastics that can be made from renewable resources, oil from alcohol than can be distilled from crops, an unlimited supply of energy from tapping solar energy directly, etc.

Eliminating waste in mining and processing:

Example: getting away from the present policy of skimming off the highest grade ores because it is "more economical", often wasting or abandoning the low grade ores because there is not enough profit involved. (In the case of coal, for every ton mined, more than 1/2 a tone is lost.)

Eliminating waste in use:

Examples: limiting the use of fossil fuels to make them last longer. (This would also reduce air pollution and decrease the rate at which our vital oxygen is consumed.)

Making more effort to conserve scrap and used metals.

Getting away from planned obsolescense in items made from non-renewable resources.

Distribution ("benefitting the most people") problems will probably be the most difficult because of the interests of the controlling companies and governments.

Concept #25, (Cont.)

Mineral resources can be classified in an abbreviated way as follows:

Metals		Non-Metals	
Ferrous	Non Ferrous	Mineral Fuels	Other Non-Metals
Iron	Tin	Petroleum	Stone
Manganese	Copper	Natural Gas	Salt
Molybdenum	Aluminum	Coal	Sulphur
	Gold		Mica
	Magnesium		Asbestos
	Platinum		Clay
	Uranium		
	Radium		

Because, as defined in the name, these resources are not renewable, they must be used for the long-term benefit of society. Oil and coal do originate from living plants originally. But because the cycle is over millions of years, these resources are classified as nonrewable.

When our supplies of iron ore are exhausted, there will be no more, yet the rate of conversion of iron ore to cars, to junyard, is appallingly rapid.

Knowledge K-12

CONCEPT #25 - The management of nonrenewable resources involves using all known methods to maximize benefits to the most people over time. Minerals are nonrenewable resources.

Teaching Activities:

"Our Mr. Sun" film, (Bell Telephone), does a good job of depicting increased energy consumption in recent centuries. Ending too optimistic. This film can be secured through your nearest Bell System Office.

Comprehension 4-6

CONCEPT #25 - The management of nonrenewable resources involves using of all known methods to maximize benefits to the most people over time. Minerals are nonrenewable resources.

Teaching Activities:

Take a field trip around your community. Have the students make a list of the wastes of nonrenewable resources that they see. (If a field trip is impossible, a field trip by means of slides or Super 8 can be taken in the classroom.) The students can then use their lists for class discussion purposes.

Synthesis 4-6

CONCEPT #25 - The management of nonrenewable resources involves using all known methods to maximize benefits to the most people over time. Minerals are nonrenewable resources.

Teaching Activities:

Have class make strips of paper representing total iron, petroleum, aluminum or etc., that was here before man. Clip off part representing amount already used. (Where is that part now?) On remaining strip, mark section indicating present annual rate of use. Discussion should include question who should have right to remainder -- this generation? Future generations? Again emphasize importance of reuse. Also emphasize problems of disposal - use of every product will produce by-products. Example: Fuel burning pollutes air; automobile disposal tremendous problem.

Analysis 7-9 10-12

CONCEPT #25 - The management of nonrenewable resources involves using all known methods to maximize benefits to the most people over time. Minerals are nonrenewable resources.

Teaching Activities:

In class compare lists and compile a single list including all nonrenewable resources. Extrapolate to give some idea of tremendous quantities involved in the U.S.; in world. Point out limited amounts available in world. (Also have class determine in what countries - if any - they might find all the nonrenewable resources on their list.) Have class list ways to reduce drain on nonrenewable resources. Teacher keep in mind:

Substitutes usually put pressure on another resource (Ex. - plastics from coal), so recycling and more conservative use are the only long term solutions. Use of mass transportation is example of way to conserve metals, fuel.

Evaluation 10-12

CONCEPT #25 - The management of nonrenewable resources involves using of all known methods to maximize benefits to the most people over time. Minerals are nonrenewable resources.

Teaching Activities:

Why is the automobile a good example of a struggle between economic interests and benefits to all people?

- It becomes obsolete fast
- It contributes to air pollution
- It uses up our fossil fuel supply
- Why do we not use smaller, more efficient engines

CONCEPT #25 - The management of nonrenewable resources involves using all known methods to maximize benefits to the most people over time. Minerals are nonrenewable resources.

Teaching Activities: (emphasis on recycling)

Have each child keep track during one day, of things he consumes and/or depreciates, listing them as renewable or nonrenewable. (Things that come from growing plants or animals are renewable, as is water because it is renewed through the hydrologic cycle.) (Encourage them to recognize that in automobile use, fuel, metals, etc. are involved.)

Have students project the amounts of each of those items they would use in two weeks; two years; ten years, etc.

Concept #26

The rate of use of a nonrenewable natural resource is dependent upon supply and demand.

The demands man is placing on the environment to yield up its assests for mans' exclusive use are increasing at a phenomenal rate - especially in the technologically advanced countries.

PROJECTED EXPANSION OF ECONOMIC DEVELOPMENTS IN THE U.S.A. TO THE YEAR 2000

These industries draw on nonrenewable resources, and directly affect the environment with their by-products.

(1947 = common base - 100%)

	1947	2000
	100%	
Population		228%
Steel ingot production		348
Petroleum (total consumption)		543
Non-ferrous metals & products		699
Automobiles (annual production)		728
Public const. of water & sewage facilities		803
Public constr. of highways		2023

The rate of increased use predicted in the above table is attributable to two things - increasing population and increasing per capita demands. There are no indications of any leveling off of these demands. Furthermore, our ability to extract and supply these nonrenewable resources to industry increases as our technological capabilities increase.

Man did not begin to draw on his nonrenewable resources in any significant way until he learned to use metals. He extracted the surface deposits first. With these sources soon depleted, he turned to more complex mining operations and exploration.

Development of the automobile has put tremendous pressure on petroleum production. Petroleum products had been used in ancient times; until the age of the internal combustion engine the demand had not been great. (A corollary is that the demand now is sustained by the supply-ers who have an interest in profits - automobile, highway, fuel producers who oppose development of other types of transportation.)

Comprehension 4-6

CONCEPT #26 - The rate of use of a nonrenewable natural resource is dependent upon supply and demand.

Teaching Activities:

Have class investigate what nonrenewable resources are involved in car manufacture, road construction (demand created by cars), automobile fuel consumption (demand created by cars).

In addition, have students find out the amount of the most significant minerals that are known to exist. Project how many years can supplies of these minerals satisfy our want for more cars.

Analysis 7-12

CONCEPT #26 - The rate of use of a nonrenewable natural resource is dependent upon supply and demand.

Teaching Activities:

Explore role of advertising in promoting buying and use of automobiles (creating demand). How much is spent on automobile advertising? What role does planned obsolescence play in creating demand? How important are cars as status symbols?

CONCEPT #27

The rate of resource use can be slowed by the development and adoption of alternatives.

The best planning produces the best alternatives. And in the case of natural resource management, it has to be long-term planning - at least 50 years - or two generations. Perhaps long-term in mans' scheme of things, but only a few seconds in terms of human history, and a split second in geological time.

Man is a recent arrival on earth. Let us think of the history of the world as a 5,000 page book with each page representing a million years. Page 1 would represent the formation of the world. About halfway through the book, primitive life would have begun in the oceans. Man would appear on the last page. And his technological era, the last 300 years, would not quite contribute the last letter of the book's last word.

In spite of this, man has achieved the status of a geological force. He has literally moved mountains, denuded hundreds of millions of acres of land, poisoned immense bodies of water, exterminated many species of organisms, and has altered the very atmosphere which he breathes. Whether we like it or not, the fate of the biological world is in our hands. To any objective observer, it is obvious we need a good pair of kid gloves, and severe changes in direction must be instituted.

The specific alternatives will have to result from careful consideration by society as a whole. But the following choices offer a general outline:

(1) We should emphasize non-material acquisition - pursuit of art, music, literature, philosophy, science, and spiritual values at the expense of material acquisition - large homes, automobiles, more highways, creature comforts, and conveniences. This value shift really represents an about face for our society and most others - at least for those whose criteria for a higher standard of living is measured solely in oil, ingots, ton-miles and megawatts. The point is, however, that if the current critical list of unrenewable resources continues to grow and certain resources do give out, the theory of limit of growth will have been proven correct. We should have already adjusted our thinking to a higher standard of living, but via spiritual, not physical growth.

(1) Human population restriction.

(3) Reduce waste in extraction.

(4) Increase the extent of reuse (recycling).

(5) Use an abundant mineral for a less abundant mineral.

(6) Synthesize substitutes.

CONCEPT #27, (Cont.)

(7) Increased economy in mineral use. If we are more conservative in our exploitation and find out mans' inventiveness does provide an unlimited resource supply, we will simply have marked time in resource consumption until these doubtful promises have been fulfilled.

The alternatives, however, often increase the rate of use of another resource. Example: Use of plastics often saves metals, but plastics demand coal as a raw material. Such juggling does not truly conserve. (The hazard involved in substituting atomic energy for fossil fuel energy was discussed under Concept #21.)

In general, we should not be so optimistic about "alternatives" that we fail to institute less wasteful procedures in mining, processing, and use of non-renewable resources. Perhaps the best "alternative" is to use less or to go without! Thus, an alternative which would conserve petroleum is for people to give up private transportation as much as possible and use instead, sophisticated mass transit systems. Use of smaller cars could decrease drain on supplies of both metal and fuel - help air pollution problems as well.

Comprehension K-3 4-6

CONCEPT #27 - The rate of resource use can be slowed by the development and adoption of alternatives.

Teaching Activities:

The teacher will post a chart with blank lines for a list on the bulletin board. Over a period of two weeks, the class will fill the blanks with ideas for recycling or reuse of materials used in their daily lives. To stimulate ideas they may investigate the contents of the family trash barrel. Examples:

Pop bottles (seen in trash) - Use returnable bottles
Pop bottles - Crush glass and reuse in glass manufacture
Tin cans - Melt down and reuse metals
Paper packaging material - Could less wrapping be used?
Vegetable waste - Could be made into composit for soil

Comprehension 4-6

CONCEPT #27 - The rate of resource use can be slowed by the development and adoption of alternatives.

Teaching Activities:

Have class members dramatize a meeting of citizens to discuss conserving of natural resources. The dramatization should have citizens airing pros and cons from individual points of view. After the dramatization the teacher should point out that while this is a fictitious situation, it illustrates the real problem of the limited supply of fossil fuels.

CONCEPT #27 - The rate of use of a nonrenewable natural resource is dependent upon supply and demand.

Teaching Activities:

A fictitious community is using fossil fuels for electricity production, home heating, and automobiles. The community is informed that there is only enough fuel to last ten years. The citizens would like to prolong this time by taking positive action. Suggestions:

(1) Build an atomic electric power plant.

(2) Operate an efficient mass transit system and severely restrict use of private cars.

(3) Meet the crucial need for water in this country.

CONCEPT #27 - The rate of resource use can be slowed by the development and adoption of alternatives.

Teaching Activities:

At higher grade level, do cost accounting comparison of relative costs of various "packaging" (bottling, etc.) for soft drinks and beer vs. returnable container procedure. Compare effects of container types on use of water, other resources, in manufacture.

CONCEPT #28

The amount of precipitation available for use by man varies with topography, land use, and applied management practices.

The water (hydrologic) cycle is as critical to life on land as the air itself or the sun's energy input, - which makes the water cycle possible. Precipitation is that portion of the cycle from which all our usable fresh water flows.

Man still has little or no control over the amount, kind, intensity, and periodicity of precipitation. His only real opportunity to manipulate the quality and quantity of his water supply is after the precipitation has fallen. All precipitation then either goes to the oceans as runoff, or is returned to the atmosphere through evaporation or plant transpiration. The water which percolates into the soil may be in storage for a long time before it flows underground to a stream, is evaporated, or transpired.

Topography largely determines the land's ability to store surface water. Flat land offers little opportunity for surface water for recreation (central Illinois). Whereas undulating land (northern Wisconsin) is dotted with thousands of lakes.

Topography also affects the intensity and duration of floods. Is the water confined in a gorge? Or, is there a flood plain? Also extreme variations in storm patterns cause floods. Long, heavy, widespread storms usually are the cause of floods on the main stems of rivers. Concentrated local storms usually are the source of damage in headwater areas.

There are an estimated 100 million acres of flood plains in the U. S. whose use should be carefully considered (as should any land use). Because these plains are flat, they are convenient for industrial and home building, agriculture, flooding for reservoir use, recreation, and they offer a source of water. Obviously not all uses at the same site can offer equal long-term benefit.

One of the best and simplest ways to minimize flood damage to buildings is simply to stay out of the way of the flood. The periodicity will vary considerably, however, from plain to plain. But this periodicity is usually well known for any given flood plain. And, if one is going to build on one of these low, flat areas, the chances of being flooded and the consequent damages must be weighed against benefits from other uses - game production, recreation, agriculture, etc.

On the uplands, mans' use has a great affect on whether water runs off into streams or percolates down to the water table. The roofs of houses and factories, schools, hospitals, streets, and highways all seal the ground from water penetration, and increases runoff which proportionately slows the recharge of ground water. This is happening while the population is increasing which, in turn, increases our need for water.

CONCEPT #28, Cont.)

There are management practices which can increase water availability for mans' use. Basically they fall into two categories:

(1) Increase water seepage into the soil through;

A. Vegetative aids - for example; good forest management, using cover crops, good crop rotation, stubble mulching. Improving soil structure with deep rooted crops and green manures (plowing in or discing in green crops, e.g., legume grass mixtures).

B. Mechanical - for example; water spreading techniques such as strip cropping, contour farming, terracing, the use of furrows, pits, wells, and flooding.

(2) Impoundment of surface water runoff in farm ponds or in dammed reservoirs.

In the final analysis, it depends on mans' understanding of the overall ecosystem and its total dependence on a pure water "bloodstream", his cultural attitudes (including economics) and how much of his natural heritage he is willing to bequeath to those who come after him.

In Wisconsin, more than 20 inches annually, of the 28-32 inches of precipitation received, is lost through evapotranspiration. Runoff ranges from 6 to 20 inches, generally more in northern Wisconsin than in southern Wisconsin. What is left seeps into the ground and is then available through wells, and as a base flow for streams. Differences in topography, land use, and applied management practices affect mainly the amount of runoff water. Hilly, dense soil areas have higher runoff than flat sandy areas. Vegetation retards runoff. Exposed soil increases runoff. Attempts to control runoff which causes flooding by building dams, fail to take into account the poor watershed practices which have resulted in the excess runoff. (Far better to spend money in watershed improvement; remove dwellings, etc. from natural flood plains and keep these under good vegetative cover.) Irrigation procedures greatly increase water loss through evaporation. (50% loss? Figure would be interesting).

CONCEPT #28 - The amount of precipitation available for use by man varies with topography, land use, and applied management practices.

Teaching Activities:

To demonstrate the absorption of water, locate a ungrazed and unburned woodlot next to a cultivated field. Remove the top and bottom from a large fruit or juice can. Mark the outside of the can in inches. In each of the spots you have selected, set each can so the end closest to the 2-inch mark is on the ground. Do not disturb the plant materials or soil in the can. (Avoid spots where it will be difficult to place the can.) Pour a measured amount of water into each can. Determine the amount of water that has moved downward at the end of each minute for a ten minute period. Students should be able to understand that soil that is cultivated cannot absorb water rapidly and much of a rainfall may run off.

CONCEPT #28 - The amount of precipitation available for use by man varies with topography, land use, and applied management practices.

Teaching Activities:

To illustrate water movement in soil, conduct the following experiment:

(a) Secure three glass tubes, 1" in diameter and about 1" long
(b) Tie cheese-cloth over one end of each tube
(c) Partially fill each tube with soil; be sure to fill each tube to the same height
(d) In filling tube, use three different kinds of soil -- sand, clay, and silt, etc.
(e) Place tubes in a shallow pan of water
(f) Allow to set for several hours or overnight.

Have students observe movement of water in soil and predict what would happen to rainfall when it falls on each type of soil.

(Be sure soil is dry for this illustration.)

Evaluation 10-12

CONCEPT #28 - The amount of precipitation available for use by man varies with topography, land use, and applied management practices.

Teaching Activities:

Students could investigate topographic map sheets of the quadrangle with their community. (These can be purchased from the U. S. Geological Survey of from the State Geological organization for $.50/sheets or maps. Sometimes these are available from local sporting goods stores.

From observations of the topographical map sheets, students should be able to identify the river flood plains if a river is available. Then the discussion can be directed into the proper and improper uses of flood plains and reasons why.

Analysis 7-9

CONCEPT #28 - The amount of precipitation available for use by man varies with topography, land use, and applied management practices.

Teaching Activities:

The students could send to The Wisconsin Valley Improvement Company, Wausau, Wisconsin, 54401, for information as to how they try to control the flow of the Wisconsin River. (Have one student write for the entire class, or have them all write and select the best letter to send.) Charts and information on the control of the Wisconsin River will be sent.

Questions may come up, such as; "How good is this?", "How does this affect fish populations, etc?", "What is happening as far as silt in the reservoirs is concerned?", "How does the company get land to make reservoirs?", "Is this right?"

Application 7-9

CONCEPT #28 - The amount of precipitation available for use by man varies with topography, land use, and applied management practices.

Teaching Activities:

Visit a farm to observe techniques of good water management. (Note that water control results in soil conservation.) Stress importance to the farm operation. County agricultural agent is a good resource person for water and soil conservation.

CONCEPT #29

As populations increase, competition for the use of water increases, resulting in a need for establishing water use priorities.

The equal distribution of natural resources over the earth's surface was discussed in Concept #24. Water is no exception. We have heard of the Sahara Dessert on the one hand and tropical rainforests on the other. Annual precipitation around the globe varies from less than 1/5 inch per year to over 300 (over 25 feet) per year. Water has long been recognized as a precious commodity in low rainfall areas. In high rainfall areas, man has been extravagant indeed! The cliche, "one doesn't miss the water 'til the well runs dry" is gaining more significance in more places every day. We should remember the world's fresh water supply, from annual precipitation falling on land, is fixed at about 24,000 cubic miles plus about 71,000 cubic miles falling on the oceans.* This may sound like a lot of water - and it is. But, there are a lot of us, increasing every day (see Concept #3), and with increasing per capita demands.

The major uses of water are for irrigation, industry, and municipal purposes. The availability of low-cost hydroelectric power drew a great deal of the wartime industry to the Pacific Northwest.

There has been a continually increasing use of water for irrigation and, or course, our ever increasing urban areas constantly demand more from the fixed supply. The water falling on the urban area provides only a small percent of its water needs. So, water must be brought in from outlying areas. For example, the Colorado River's headwaters are in the mountains of Wyoming, Utah, and Colorado, and supply water to users 1,000 miles away - in southern California, Arizona, and sections of Mexico.

Much of the increased demands are being met by "mining" our "fossil water" underground. This supply, over the world, is about 30 times as great as all the world's surface rivers and lakes. As the local watertable is exhausted in Calibraska, U.S.A., the underground water reserves under the Yukon will not be of much help. Distribution is a problem and, because of energy requirements to distribute almost any commodity, will remain a problem for the foreseeable future.

Based on a daily requirement of 120 gallons, the average price that you pay for water is about five cents a day, or $18.25 per year. Because there is not enough available in all places to satisfy all the needs, water, like many other economic goods has begun to command a price, I am sure an unthinkable situation to most American indians. But water's price is determined, in the final analysis, by supply and demand, like any other commodity.

How is water used in your area? What is its price today? Ten years ago?

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*Desalinization of salt water is, by comparison, insignificant and will remain so in terms of the explosively increasing demands.

CONCEPT #29, (Cont.)

As water use requirements increase, there will be less water available to meet each demand. Therefore, priorities will have to be set. And a very important question that will have to be answered is "How much of our fixed water supply do we wish to sacrifice to consumption, production of food, manufactured goods (needs + luxuries) and waste disposal?" vs. "How much do we wish to preserve for recreation (swimming, fishing, sailing, etc.), for preserving disappearing species of plants and animals and scientific research for the betterment of mankind now and in the future?" Choices have to be made, and now! Many of them are irreversiable! Again, these decisions depend on mans' accurate assessment and understanding of his environment and his relationship to - and role in it.

Major uses of water: Household, agriculture, industry, recreation, waste carrying, commercial fishing, hydroelectric power generation, navigation.

Conflicts: Much irrigation water is lost to atmosphere. It may or may not return to the region as rainfall. So, if well water is used for irrigation, it may cause a net reduction in the region's ground water supplies. Municipalities and industries which draw water from a stream and then discharge sewer systems back into the stream may impair water quality for downstream users.

Diversion of waters for irrigation or for hydroelectric power plants during the dry season may affect recreation or commercial fishing.

Draining of wetlands for farming may affect wildlife, water levels, and - if the drainage enters a lake - over fertilization of the lake with loss of recreational values.

Knowledge K-3

CONCEPT #29 - As populations increase, competition for the use of water increases, resulting in a need for establishing water use priorities.

Teaching Activities:

Have the class calculate from their family water bills, the average daily per capita water consumption. Use a large container and measure into it an amount of water representing average daily per capita water consumption as calculated.

Application 4-6

CONCEPT #29 - As populations increase, competition for the use of water increases, resulting in a need for establishing water use priorities.

Teaching Activities:

Each student can keep track of how much water he uses, his family uses. This could be compiled into class data or broken down into an average per person, and multiplied by the number of people in a town, state, etc.

Analysis 7-9

CONCEPT #29 - As populations increase, competition for the use of water increases, resulting in a need for establishing water use priorities.

Teaching Activities:

Have the students find where the major cities get their water. What problems have developed?

Analysis 4-6

CONCEPT #29 - As populations increase, competition for the use of water increases, resulting in a need for establishing water use priorities.

Teaching Activities:

Discuss the many uses of water with the class. During the discussion, compile a list on the chalkboard or overhead projector of these uses.

Require the students to rate the uses according to their importance.

Application 7-9

CONCEPT #29 - As populations increase, competition for the use of water increases, resulting in a need for establishing water use prioities.

Teaching Activities:

Have the class calculate or find the average per capita use of water in their city; in the U. S. Discuss other uses of water (steel production, etc.) which affect these figures.

CONCEPT #30

The quantity and quality of renewable resources can be extended by reproduction, growth, and management.

This is an apparently obvious concept. It simply suggests man can improve on nature in quantity and quality. There is no law that says that natural developments are necessarily the best. We realize that organisms and processes develop purely by chance, that is random, unplanned selection. Those organisms and processes offering the highest survival benefits reproduced and persisted under the environmental circumstances prevailing at that time. Through such trial and error, man along with over a million other organisms, evolved - acting and interacting with each other and their environment.

But, we must remember first; that the very recent arrival, man, has defined resources, both renewable and nonrenewable, in terms of his own value system. Second, he is now relating all these resources to the patterns of use of the single dominant organism (himself) from the millions of organisms of the whole organic picture. In other words, man the hunter-food gatherer had little impact on his environment. But modern technological man has developed awesome tools with which to alter his environment and the species composition to suit his own immediate needs and desires.

He is converting ecosystems stabilized by great species diversity to simple unstable mono-culture ecosystems (corn, wheat, etc.) wholly dependent on mans' environmental manipulations. So, the more he manipulates, the more he has to manipulate.

Technology has been turned on renewable resources with some positive gains. Genetic programs in forestry have improved timber yields as have management techniques of harvesting. Through clear cutting in forest areas to develop even-aged timber, surface water yields have been increased. But by far, the greatest production of renewable resources has been achieved by removing the particular species (corn, fish, rubber, etc.) from its environmental context, improving its monoculture combined with genetic programs.

The irony of it is that to date man has been so successful in increasing his food supply and in crushing his disease enemies, he now faces the population birthquake.* If the burgeoning population with its attendance massive demands on the world's resources is not soon diminished, man may be the author of his own demise.

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*The present rate of population increase projects in 900 years to the absurd figure of 100 people per square yard. The point is, the present trend has to be reversed.

Analysis 10-12

CONCEPT #30 - The quantity and quality of renewable resources can be extended by reproduction, growth, and management.

Teaching Activities:

A pure stand of trees could be used as an example of how man has tried to extend his forestry resources. A field trip would help to enrich this activity. A discussion of the desirable and undesirable effects could be initiated. (Many discussion methods can be used - two people, panel discussion, groups of three or four with a recorder, circle discussion, etc.) Example might be white pine (pinus strabus) where clear stands have invited white pine tip weevil. Clear stands of Scotch pine (pinus sylvestrus) have invited root collar weevil and white spot. Ecologically, the clear stands are a desert in terms of wildlife and other plant life. This should be very evident if the students are asked to keep a record of plant and animal life observed.

Knowledge 4-6

CONCEPT #30 - The quantity and quality of renewable resources can be extended by reproduction, growth, and management.

Teaching Activities:

Most counties have a County Forester who is responsible for managing forest lands in the county. Write to this individual and ask what activities he is engaged in that are designed to improve either the quality or quantity of forests.

Comprehension 7-9

CONCEPT #30 - The quantity and quality of renewable resources can be extended by reproduction, growth, and management.

Teaching Activities:

With the assistance of the county forester or your school agriculture instructor, conduct a field trip to a plantation or woodlot. Demonstrate planting, natural seeding, improvement cutting. Compare tree growth between trees that have had ample growing space and another that has grown up under crowded conditions. If possible, cut the trees and compare growth rings.

Comprehension 10-12

CONCEPT #30 - The quantity and quality of renewable resources can be extended by reproduction, growth, and management.

Teaching Activities:

Management of renewable resources is one of the responsibilities of the State Department of Natural Resources. Have the students determine the various resources that are managed by this department and what activities these individuals engage in. If possible, develop lists of resources and ways that the quality or quantity is being extended. Often this individual will be willing to speak to your classes.

CONCEPT #31

Soil is classified as a renewable resource, but its natural rate of renewal is extremely slow:

Five major factors control soil formation; climate, parent rocks, living organisms, topography and time. These factors control rock weathering and the rates of gains, losses and changes throughout the soil profile.

Although soil may be classified as a renewable resource, it is much better considered nonrenewable because of the long time factor involved (discussed later).

Every soil has a profile - a succession of horizontal layers down into loose weathered rock. There are always two or more layers known as horizons. The various horizons differ in one or more properties such as color, texture, structure, consistence (resistance to crushing and its ability to be molded or changed in shape), porosity, and reaction. Horizons may vary in thickness from a fraction of an inch to several feet. And generally horizons merge with each other, lacking sharp boundaries.

Most soil profiles include three master horizons, identified by the letters A, B, and C. Some soils lack a B horizon and are said to have AC profiles.

The A horizon is the surface horizon (surface soil) of a mineral soil having maximum biological activity, or maximum removal of materials dissolved or suspended in water (eluviation), or both.

The B horizon (often called the "subsoil") is usually beneath the A horizon, or surface soil - unless the A horizon has been eroded away. First, it has accumulated clay, iron or aluminum, with accessory organic matter from the A horizon above. Or, there has been clay development in place. Second, the B horizon has a blocky or prismatic structure, or it has some combination of these features.

The A and B horizons together are known as the solum and are formed by the true soil-forming process.

The C horizon is unconsolidated rock material in the lower part of the soil profile like that from which the upper horizons (or at least a part of the B horizon) have developed.

Let us consider briefly, the five major factors which control soil formation from parent rock.

1. Climates vary in their heating - cooling, freezing - thawing, and wetting - drying, all of which tend to weaken the rock structure. Gradually rocks thus disintegrate and decay. In fact, climate is so important in soil formation that the broad soil regions of the world tend to follow the distribution of climates. Soil and climates are

not identical, however, because five factors, not one, control soil formation.

2. Parent rock is sometimes called a passive factor in soil formation. The nature of the original rock and the stage of weathering affect the fertility and water relationships of soils.

3. Living organisms are controlled largely by the climate and stage of soil development. The pioneer plants are usually simple forms such as lichens, bacteria and fungi. Larger and more complex plants soon follow. Small animals then join the biological community in the infant soil.

As these organisms grow and die, their bodies contribute both minerals and organic matter. Plants largely determine the kinds and amounts of organic matter that go into a soil under natural conditions. They also govern the way in which it will be added, whether as leaves and twigs on the surface, or as fibrous roots within the profile.

Some plants take their nitrogen from the air and add it to the soil as they die. Deep-rooted plants reverse leaching processes in part - taking up calcium, potassium and phosphorous and other nutrient elements from the C horizon or deeper and depositing it on the A and B horizons when they die, - a kind of "pumping" action.

Ants, earthworms, and burrowing animals also affect soil development and horizon mixing.

4. Topography. Soil profiles on steep slopes generally have indistinct horizons and are shallower than those on gentle slopes. Low and flat topography often means that extra water is added to the soil. If water stands on the surface, peat deposits may be formed. Topography thus influences the moisture regime in soil and the erosion from its surface.

5. Time required for soil formation depends on the above four factors, and where the process must start. Soil formation proceeds in steps and stages, none of which is distinct. The two major steps are first, accumulation of soil parent materials which follows from the weathering of rocks which is slow, gradual and continuous. Usually the rocks disintegrate followed by mineral decomposition. Second, horizons differentiate in the profile. Initially these horizons are faint and hard to distinguish. If conditions are favorable, these horizons become distinct with the passing of time.

If the soil forming process starts with freshly exposed limestone, for example, millions of years may pass before soil horizons have formed. Most of this time will have been used to weather the rock to soil parent material.

When starting with windblown silty sediments (loess), distinct B horizons formed in about twenty thousand years in eastern Iowa. But, under favorable conditions, soils with B horizons high in humus formed in sands laid down on Roman ruins in parts of western Europe. The sands are no more than two thousand years old.

(Concept #31 . . . Continued)

An A horizon formed in glacial drift which had been exposed for 100 years. This horizon contained as much organic matter as many eastern soils.

Differentiation of thin A and B horizons within 50 years has also been observed in former plow layers in eastern North Carolina.

It should be obvious from the above discussion that man, whose calendar is divided into days, weeks, and months, must count on soil conservation - NOT soil renewal.

When sod is ruined by poor agricultural practices and abandoned, natural invasion of pioneer plants and decay of plants and animals will eventually restore the soil fertility - but this will not be in the time of our civilization! Even under the best conditions, it takes thousands of years for a few inches of soil to form. In the U. S. there are 200 million acres of completely ruin land.

Ohio River flood of 1936 removed 300 million tons of topsoil from a watershed which had once been protected by forests.

Soil is formed of rock and organic particles. The rock particles are formed from parent rock by physical action (water, wind, heat and cold), by chemical action (acids produced by plants and by combination of CO_2 in air with rainwater to form carbonic acid (H_2CO_3), and by action of prying plant roots.

The organic matter consists of the partially decayed remains of once living plants and animals. Green plants in creating their own substance from the raw materials of water and carbon dioxide (plus small quantities of minerals from the soil) thus provide the material which through death and decay becomes soil enriching humus. Photosynthesis therefore is an important factor in soil manufacture.

Knowledge K-3

CONCEPT #31 - Soil is classified as a renewable resource, but its natural rate of renewal is extremely slow.

Teaching Activities:

In areas where sandstone is available, furnish each child with two pieces of sandstone and have them rub them together to make small particles. Compare these particles with sand from a conservation area. Have children gather leaves and dead grass, bark from dead limbs, and break this up as fine as possible. Mix this with the sand they have ground. Have half of the class try to match their soil with soil from a hilltop, and the other half match their sample with soil from a lower place.

Application K-3

CONCEPT #31 - Soil is classified as a renewable resource, but its natural rate of renewal is extremely slow.

Teaching Activities:

To demonstrate rate idea: Have a large tub of soil. Have two children with cups taking soil out to demonstrate removal of soil by erosion while two children try to keep tub filled using teaspoons to demonstrate slow rate of soil formation.

Comprehension 4-6

CONCEPT #31 - Soil is classified as a renewable resource, but its natural rate of renewal is extremely slow.

Teaching Activities:

Stress urban impact on soil loss: If your city has settling basins as part of storm sewer system, find out how much silt has to be dredged or removed from such basins per year.

Comprehension 4-6

CONCEPT #31 - Soil is classified as a renewable resource, but its natural rate of renewal is extremely slow.

Teaching Activities:

Have students heat pieces of limestone and drop them into cold water. Have them relate this to natural weathering and soil formation.

CONCEPT #31 - Soil is classified as a renewable resource, but its natural rate of renewal is extremely slow.

Teaching Activities:

At beginning of school year, choose a good sized local rock. Have the students weigh it. Put it outdoors in an exposed position. At end of school year weigh it. (Be sure to use same cleaning and drying technique at beginning and end of experiment.) Determine how much of the rock has been lost through weathering (if any). This loss represents the part of the rock which might become available for soil formation in nine months. Discuss significance of this very slow loss.

CONCEPT #31 - Soil is classified as a renewable resource, but its natural rate of renewal is extremely slow.

Teaching Activities:

1. If it is possible, dig a soil pit behind your school and have the students decide how thick the various layers are.

2. Discuss whether you consider the soil in the pit a good soil or a poor soil. Why? What is its water holding capacity.

3. Have the students dig out a 1' square cube of soil as deep as possible. Have them list what they find in both soil characteristics as well as animal life.

4. A required reading on lichens would help in ideas about soil formation.

CONCEPT #31 - Soil is classified as a renewable resource, but its natural rate of renewal is extremely slow.

Teaching Activities:

Have students dig a hole, or take students to roadcut to show a soil profile. Have child draw the profile by actually placing a piece of paper or cardboard against it. Discuss the characteristics of the three prominent layers evident.

Evaluation 10-12

CONCEPT #31 - Soil is classified as a renewable resource, but its natural rate of renewal is extremely slow.

Teaching Activites:

Have students find out how much land is permanently taken out of production by a mile of highway; a cloverleaf turn; a large shopping center, etc. Have them translate this into bushels of wheat or corn or number of cattle which could have been supported. Relate this to how many people this land might feed.

Concept #32

Maintaining, improving, and restoring soil productivity is important to human welfare:

The attached map of erosion on cultivated land in the United States shows just how prodigal Americans have been with their inherited soil wealth.

The time required for nature to develop a soil profile was discussed above in concept 34. The obvious advantage of having high yielding fertile topsoil over low yielding unfertile subsoil would seem to be too obvious to warrant discussion. If true, then, why were our fertile topsoils allowed to erode away as indicated in the accompanying map? This can be attributed to several factors:

1. The mistaken idea a few decades ago that there was unlimited farmland which made conservation practices unnecessary. There was always more land to the west.
2. Lack of recognition of the damage being caused. Even though the erosion took place over a few decades, what was happening and the extent were simply not appreciated - especially sheet and wind erosion.
3. There were no legal restraints.
4. Some conservation practices are fairly expensive in the short term and hence may be resisted by the farmer. Or, he simply may not be able to afford certain construction measures. On the other hand, as food becomes in shorter supply around the world* conservation techniques will not appear to be as expensive - certainly nowhere near as expensive and time consuming as soil rehabilitation. As in most other situations, it's easier to stay out of trouble than to get out.

Plant and animal life depends on soil. Each generation has an obligation not to impair the agricultural base on which future generations will depend.

With hunger already a harsh reality in many parts of the world and world population growth rate alarming, soil husbandry becomes ever more imperative.

Urbanization is a new threat to productive soil. Thousands of acres every year are affected by "concrete-asphalt blight" and no longer supply food for a hungry world.

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*The per capita food production for the world hit a peak in 1958 and has been decreasing since population is increasing faster than food production.

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Knowledge K-3

CONCEPT #32 - Maintaining, improving, and restoring soil productivity is important to human welfare.

Teaching Activities:

Grow a food plant (i.e., a bean) in subsoil; in sand; in topsoil. Discuss importance of good soil in food production

Use an example in literature of human suffering caused by dust bowl, etc.

Application 4-6

CONCEPT #32 - Maintaining, improving, and restoring soil productivity is important to human welfare.

Teaching Activities:

Pose the question to the children -- "Are we gaining or loosing soil or productive land?" Why? (Conrete blight - urban sprawl)

Analysis 4-6

CONCEPT #32 - Maintaining, improving, and restoring soil productivity is important to human welfare.

Teaching Activities:

Have children trace food chains and find what is common to each food chain. They will conclude that all can be traced back to the soil.

Evaluation 10-12

CONCEPT #32 - Maintaining, improving, and restoring soil productivity is important to human welfare.

Teaching Activities:

Government agriculture programs are sometimes in conflict with each other. A farmer can receive financial assistance to develop land for agricultural production. He can also receive assistance for taking land out of production. Have students discuss what possible benefits can be realized by having these two conflicting agricultural programs.

Analysis 7-9

CONCEPT #32 - Maintaining, improving, and restoring soil productivity is important to human welfare.

Teaching Activities:

Given: In world today there is approximately 1 acre per person of agricultural land. An estimated 15,000 persons starve to death per day. In this context discuss effect of loss of soil through mismanagement. (Also discuss effect of population increase.)

Concept #33

Soil capability can be maintained by utilizing known agricultural processes:

Research and field trials over the years have provided us with a rich storehouse of knowledge on how to obtain high sustained yields. But getting this knowledge accepted by the farmer and applied is another problem. In general, the closer the agriculture process simulates a natural vegetative cover, the better will be the high sustianed yield. For example, keeping the ground covered with vegetation as much of the time as possible. In nature, bare exposed ground is a rarity. Even after a forest or prairie fire, there is burned debris on the ground. And vegetative regeneration is extremely rapid. Well developed root systems aid in holding soil and in water penetration.

Fertilizers should be added to the soil to replace the minerals removed in the harvest. But the fertilizers should be added so as to minimize or eliminate fertilizer runoff. First, this is a loss to the farmer and it enriches the streams and lakes into which it flows causing noxious algae blooms. An especially bad practice in this regard is manure spreading on frozen ground. The spring thaw and rains wash off enormous amounts depriving the soil of the nutrients and damaging surface waters. Nature recycles its nutrients through the slow decomposition and release of nutrients of dead vegetation with essentially no loss from runoff.

If annual soil losses can be kept below 4 to 5 tons an acre on deep soils and 2 to 3 tons an acre on shallow soils, soil washing, gully formation, and silting are not excessive.

The principal factors causing soil erosion from rainstorms are the amount, intensity, and distribution of the rain; length and steepness of slope; kind of soil; tillage and conservation practices used; and kind and amount of plant cover.

The attached sheets (1) amplify and give examples of some of the above points.

"There is no way to husband a piece of land so well as to let something grow on it and return its residue to the soil." Peter Farb - Living Earth

The natural climax community is a reliable indication of what type of farming a given region may support. Failure to recognize this factor has resulted in dust bowls in our own country, wastelands in Spain, Italy, Greece, etc.

Certain lands should not be either cropped or grazed - too steep, soil too thin. Other lands should be used only with utmost care to guard against soil erosion.

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Knowledge K-3

CONCEPT #33 - Soil capability can be maintained by utilizing known agricultural processes.

Teaching Activities:

Build hills of soil. Have students lightly sprinkle water on these to simulate rain after:

- making ridges up and down the hill
- making contoured ridges covering the hill with grass clippings, leaf mold, straw, etc.

A laundry sprinkler works well. The amount and rate of application should be the same in each case.

Vary steepness of slope and kind of soil and observe effects. Note that if soil is not protected by plants soil will move downhill at an observable rate regardless of treatment. The best one can hope for if land is plowed and exposed is to slow down the erosion.

Comprehension K-3

CONCEPT #33 - Soil capability can be maintained by utilizing known agricultural processes.

Teaching Activities:

Fill eight garden flats with soil.

Start grass seed in half of the flats. When grass is 1½ inches high, tilt one with grass, one without, at each of four different angles (for example, roughly 15°, 30°, 45°, and flat). Sprinkle water - same amount to each - and observe amount of soil run-off. Discuss importance of plant cover in maintaining soil on a hillside.

Comprehension 4-6

CONCEPT #33 - Soil capability can be maintained by utilizing known agricultural processes.

Teaching Activities:

Investigate what happens to topsoil in a new subdivision in your city. Are provisions made to save the topsoil when excavating and then to spread it on the lot as a base for lawn and landscaping.

Application 4-6

CONCEPT #33 - Soil capability can be maintained by utilizing known agricultural processes.

Teaching Activities:

Take samples from soil profile where topsoil is clearly evident. Grow corn, tomatoes, or etc. in pots (several seeds) filled with topsoil, and in others filled with subsoil. Compare results and discuss importance of keeping topsoil on the land.

Comprehension 7-9

CONCEPT #33 - Soil capability can be maintained by utilizing known agricultural processes.

Teaching Activities:

Bring the U. S. Soil Conservation Service in to work with the class or a group of classes. (Mention this Concept to Soil Conservation personnel so they are prepared to cover it.)

Analysis 7-9

CONCEPT #33 - Soil capability can be maintained by utilizing known agricultural processes.

Teaching Activities:

Discuss the problems a farmer faces in improving the capability of the soil and the need for soil testing.

Using the Hellige-Truog Soil Reaction (Ph)tester, demonstrate how soil can be tested for acidity. Have each student bring a sample of soil from their home garden if possible. If not, collect soil samples on a short field trip from the school. Have each student perform a soil test.

Discuss the results obtained in relation to what the farmer would do next, and why.

Analysis 10-12

CONCEPT #33 - Soil capability can be maintained by utilizing known agricultural processes.

Teaching Activities:

Discuss the dependence upon nutrients from the soil for plant growth. Collect root systems of legumes and examine for nodules. Discuss the need for nitrogen by plants.

Concept #34

Land zoning, a practice based on value judgements, will result in land uses which will meet the need of society:

Long before the United States was formed, the tiny settlements along the Atlantic coast were adopting measures to restrain people from using their land in ways that would cause injury to others or to the community.

The earliest measures grew out of unhappy experiences with explosions and fires and were simple regulations to keep gunpowder mills and storehouses outside a settlement.

Market towns, like Boston, were authorized to assign locations for slaughterhouses, stillhouses, and buildings in which tallow was tried and leather was tanned.

The early laws were passed in the interest of people's health, comfort, and safety. No more restraint was placed on the use of private property than was deemed necessary to protect the rights of others.

As the country grew, cities and problems grew. The way people used their land sometimes hurt others. Areas with mixtures of homes, stores, and factories sometimes ended as slums. Slums sometimes became hazards to health, safety, morals, and the general welfare.

As was the case many years before, vexing land-use problems resulted in the shaping of corrective measures. Separate zoning districts were created for homes, for business, and for industry. Conflicting land uses were thus set apart. Other zoning regulations were shaped to prevent overcrowding. This was done by limiting the height and size of buildings. The same objective was attained by regulating the size of building tracts and yards. Larger lots with ample yards allow for fewer houses and fewer persons on an acre.

A bursting of city boundaries in the booming 1920's brought unguided growth to the fringes of cities, but it was gentle compared to what was to come later.

Urban expansion became an explosion after the Second World War. All over the country new forces transformed rural communities. Good roads and automobiles permitted city people to spread over the countryside. Farm people in great numbers found employment and new homes in and near urban centers.

As in colonial days, the problems stem from unwise relationships in the uses of neighboring tracts of land. In colonial days, however, the problems were obvious, and the corrective restraints were simple. Today's problems are a complex mixture of fiscal matters, public services, the use and changing values of land, health, safety, and attitudes.

(Continued . . . #34)

A good zoning ordinance is a useful tool for assuring development according to the master plan. It is, therefore, implicit that the master plan be based on a sound inventory of all the land features - soils, water cycle, topography, plant and animal life, historical reference points, relationship to surrounding features, etc. Too often insufficient time and expertise is devoted to this inventory resulting in weak master planning.

Many agricultural counties and townships have three to five kinds of districts. Most county ordinances establish agricultural, residential, business and industrial zones.

Places that are especially well suited to certain kinds of uses ordinarily should not be diverted to other uses that might conveniently be located elsewhere. If the better soils are to be devoted to factories or homes, agriculture may be forced out, and a valuable agricultural base may be lost unnecessarily.

The Army Corps of Engineers has a policy to require assurance from local governmental units against forms of encroachment on flood plains that would endanger or make ineffective the protection provided by the remedial works. Wider use of all available means to regulate the use of flood plains could mean significantly lower public expenditures for flood control.

Today urbanization in Dane County is eating up some of the richest farmland in the U.S. Such rich agricultural land should be zoned agricultural. This would remove the economic pressures (high land value so high taxes, tempting offers of developers) which now cause farmers adjacent to urban areas to give up their farms.

Zoning can protect watersheds by keeping lands unsuitable for agriculture or development under natural vegetation. Conservancy zoning also protects wildlife habitat.

We must get away from our tradition that a property owner can do what he likes with his land, without concern for the need of society.

Flood plain zoning, now becoming a reality in Wisconsin, can help prevent erosion, pollution by septic tanks or stored industrial materials, and the foolish expense of dams to protect buildings (and whole towns) which should never have been built in the flood plain in the first place.

The U.W.'s Phil Lewis has developed some very thoughtful, provocative and practical recommendations for identification and preservation of environmental corridors. An inventory he conducted showed how most of the chcice geologic, wildlife, historic, esthetic, etc. areas in Wisconsin line up in continuous corridors, usually following rivers. Land use zoning would be a useful method for preserving these corridors.

(Continued . . . #34)

Land use zoning as a tool in planned urban growth cannot be overemphasized. Cities should not grow as an unchecked cancer into prime farm or recreational areas. Areas best suited for development should be identified in advance.

England has very comprehensive and effective land use planning enforced by the counties. - Good classroom study perhaps.

Synthesis 7-9

CONCEPT #34 - Land zoning, a practice based on value judgments, may result in land uses which will meet the need of society.

Teaching Activities:

Role playing - for example:

Farmer with prime agricultural land approached by man who wants to start a large salvage operation (junk yard) and offers to pay him a large sum for use of land.

Developer wishes to build apartment complex on wetland - will drain it, make lagoon, etc. Argues that this will increase tax base, make "useless" land useful. Community leaders interested in environment oppose on basis of lake deteriorations, effects on ground water, wildlife, etc.

Large city wishes to develop modern landfill waste disposal operation on nearby land. City officials attend meeting of people living near the proposed site.

Evaluation 10-12

CONCEPT #34 - Land zoning, a practice based on value judgments, may result in land used which will meet the need of society.

Teaching Activities:

If your county is zoned, secure a zoning map from the Zoning Office at the County Court House. Have the students analyze the map and determine what factors must have been considered in zoning the county as it was. Propose changes that might be considered in upgrading the zoning plan.

CONCEPT #34 - Land zoning, a practice based on value judgments, may result in land uses which will meet the need of society.

Teaching Activities:

Provide area map as model with color keyed areas marked as wetlands, good agricultural land, hills, forests, etc. Have students decide how land would best be used in a rural setting. Then state that 100,000 people will have to be situated there with appropriate schools, business, etc., and have them change the model to accommodate this urbanization while still considering good environmental planning.

If in a suburban area, examine own neighborhood and consider former use of land, whether zoning and developing have taken best use of land into account.

High School Geography Project: Port City Model is a recommended activity.

Knowledge 4-6

CONCEPT #34 - Land zoning, a practice based on value judgments, may result in land uses which will meet the need of society.

Teaching Activities:

Have the students find out whether their community is zoned. Is everyone pleased with zoning? Why or why not?

Students can interview their neighbors and get their reaction to the zoning ordances of their community.

Concept #35

To reproduce the structure of the natural environment is exceedingly difficult:

Many topics on the surface may look relatively simple. But when one gets involved in a given subject he is likely to be surprised at how much has already been learned and probably even more surprised at how much remains to be learned. So it is with our natural ecosystems.

When man creates a simple ecosystem, his backyard garden, a raspberry patch or an apple orchard, he must lavish on it continual care. He uses all kinds of chemicals and mechanical techniques so his wanted species can survive. His system is an imbalanced one so man must forcibly maintain the "balance."

To reestablish a natural ecosystem requires introducing all of the organisms in the right proportions at the right time - an impossible task. Especially so when essentially all ecosystems still have undiscovered and unclassified species. If common species are brought in early, they can completely dominate the site and make it all the more difficult for the rarer or less aggressive species to establish themselves.

If it is a natural land ecosystem, for example a natural prairie or forest, natural succession may take place through invasion but this is a very slow process. This is another excellent reason for preserving natural areas for research, teaching, enjoyment and as a genetic warehouse.

Nature's succession takes hundreds of years - a natural community is an intricate complex web or interrelationships.

Years ago fumes from a copper smelter killed a large area of forest in Tennessee. Every year soil washed down the valley from the bare hills to end up in a reservoir 5 miles away where it silts up the water of the reservoir. Attempts have been made to plant the bare hills - even with desert grasses but nothing will grow in the moving soil. The hills are a barren eroding wasteland and man is unable to restore the destroyed natural community.

In a sandy area near the Wisconsin River (Arena and Spring Green area) prairie plants once held the dry sand in place - a varied assemblage of grasses and colorful flowers with adaptations making them eminently qualified for such a situation. This was the community nature indicated was best suited for this place; man tried to farm the land and thus destroyed the tenuous bond between roots and sand grains. The result: a sand blowout, the crop a failure, the prairie unable to re-invade in the shifting sands. Pines are being planted - they are stunted and many die. Even if they should succeed, a pine plantation is a far cry from a natural community!

Knowledge K-3

CONCEPT #35 - To reproduce the structure of the natural environment is not possible.

Teaching Activities:

Have the students build an ecosystem such as a terrerium or an aquarium. This should bring out many of the interrelationships.

A simple terrerium could be constructed in a large jar or in a frame enclosed with plastic. (Many helps can be secured from science books.)

Analysis 4-6

CONCEPT #35 - To reproduce the structure of the natural environments is not possible.

Teaching Activities:

Take students to different areas and have them try to identify whether it is a natural area or not. Is a farm a natural area? (It is not because we are interrupting natures balance.)

Synthesis 7-9

CONCEPT #35 - To reproduce the structure of the natural environment is exceedingly difficult.

Teaching Activities:

Given a hypothetical 40 acres, have the children consider what would be needed to put that 40 acres into a corn field. (x bushels of corn, fertilizer, plow -) Consider what would be needed to establish a forest ecosystem on the same 40 acres. To get at this complexity, have the children list all the plants and animals they associate with a forest. Committees could take each animal listed and investigate what it would need in order to survive (food, shelter), and use the results of this research to enlarge the list. Compare the resulting complex list with the simple man maintained corn field.

CONCEPT #36

Plants and animals are renewable resources:

Renewable resources are resources that can be fairly readily replaced either physically (water) or by reproduction (living organisms). Wild plants and animals are extremely variable in their ability to reproduce in captivity or under unnatural conditions. Certain plants require acid bog conditions to survive. Others may need the acid needle litter of a pine forest, near neutral or alkaline conditions of a sugar maple forest, a forest of a reasonable size to reduce wind velocity, or a particular insect for pollination. Hence the best way to assure a continuing supply of many plant species is to preserve natural habitat.

Most wild animals are even more dependent on habitat for successful reproduction than are the plants. In addition to habitat destruction, many animals have been hunted and/or trapped for their fur, meat, feathers and sport. As a result many species are now extinct - curlews, passenger pigeon, auk, Carolina parakeet, and heath hen. Species no longer present in Wisconsin include the elk, moose, woodland caribou, bison, wolverine, marten, fisher, and cougar. The timber wolf and Canada lynx are close to extinction in Wisconsin.

Species on the endangered list in the U. S. include the grizzly bear, sea otter, key deer, blackfooted ferret, bighorn sheep, whooping crane, lake sturgeon, trumpeter swan, California condor, prairie chicken, and everglade kite.

These species were simply unable to withstand the pressures applied by the expanding human population. People have been slow to appreciate either the danger to wildlife survival and in the long run the threat to mankind himself by indiscriminate destruction of natural habitat.

Even if the population size of a particular species is drastically reduced and then brought back, the regenerated population will be markedly different than the original population in genetic makeup. The renewal population will be much more homogeneous because all the individuals will have inherited similar characteristics. Any undesirable characteristic (higher disease susceptibility, any senses impaired, etc.) has the possibility of being present in a proportionately larger number of the progeny of the reduced population. A concept called - through the eye of the needle.

Some populations have been able to maintain themselves quite well in the presence of man, for example, muskrats. And deer thrive on cut-over regenerating land. Consequently, there are more deer in Wisconsin than prior to the settlers' arrival. The beaver still plays an important role in the fur market, bringing in well over $1000,000 annually.

So to permit renewable resources the opportunity to renew themselves, we must understand their life needs - an intimate understanding of their ecology and the role they play for mans' long term benefit.

Renewable in the sense that with good management practices they can be harvested and continue to produce a new harvest. Where good management is not practiced, extinction of species can be an irreversible

Concept #36 . . . Continued)

result. Example: passenger pigeon, shot in incredible numbers during early settlement of the midwest, extinct today.

The use of pesticides today threatens many animals with extinction. DDT and other persistent chlorinated hydrocarbons have been implicated for several years in the decline of reproductive success in the bald eagle, peregrine falcon and other predatory birds. The pressure of chemical and agricultural interests concerned with economic welfare until fairly recently outweighed the expression of environmental concern on the part of conservationists. Legislation now is forthcoming in several states (including Wisconsin) to outlaw or severely restrict the use of such compounds. The recent publication (July 1969) of results indicating carcinogenicity (cancer producing ability) of DDT and other insecticides may speed restiction, - man always being most concerned where the human resource is threatened.

Knowledge K-3

CONCEPT #36 - Plants and animals are renewable resources.

Teaching Activities:

In the fall of the year, have the children collect seeds from various species of plants. Plant the seeds in flower pots and have the children care for them. Further study how seeds are scattered by people, water, wind and animals can follow. A field trip to a natural area in the fall can be used to illustrate how people and other animals scatter seeds.

Comprehension 4-6

CONCEPT #36 - Plants and animals are renewable resources.

Teaching Activities:

Secure some fertile eggs from a hatchery and a small portable incubator. Specific instructions for incubating eggs are usually available with the incubator or from a biology activity book. When eggs are about to hatch, allow the children to observe the chicks pick their way out of the shell.

This activity will show how fowl populations are maintained.

Evaluation 10-12

CONCEPT #36 - Plants and animals are renewable resources.

Teaching Activities:

Have the students select one renewable resource and develop a report on what needs to be done to insure that the resource selected is maintained as a renewable resource.

Application 7-9

CONCEPT #36 - Plants and animals are renewable resources.

Teaching Activities:

How does pesticide use threaten many animals when the amount of pesticide does not break down and builds up with each progressive member of the food chain.

This could be shown by having a number of graduated cylinders, label each cylinder an organism. Put the same amount of water in each, then proceed to say that the grass was sprayed with DDT or a chemical that will not break down. As the grasshopper eats the grass he gains all the DDT, and on up the line. It might be interesting to have a small amount of $NaOH$ in the water of all the containers but one. In this one container, have some phenolphthalein which will turn red when the liquids are poured in.

Analysis 7-9

CONCEPT #36 - Plants and animals are renewable resources.

Teaching Activities:

Explain the asexual and sexual cycles as they apply to various plants and animals. Field trips can be taken to observe plant reproduction (pollination - seed formation). Sexual reproduction in animals can be demonstrated by classroom animals or in the spring by collecting frog eggs and watching stages of metamorphosis.

CONCEPT #37

In most countries, wildlife is a public resource:

Wildlife generally suggests to most people, deer, wild ducks and geese, trout, etc. This is game and are controlled by bag limits, season of harvest, etc., Wildlife should be considered in its broad context, that is, wild as opposed to domestic life - game, to be sure, but also Trilliums (not tulips), chipping sparrows (not house sparrows), sunfish (not goldfish), or wolves (not dogs). In other words, wildlife includes not only those species which man identifies as being of direct benefit to himself through food, fur or sporting value, but also all the other wild species which provide mans' preferred species with the food, cover, and other life needs.

Wildlife is usually a public resource because the individual cannot protect it. Too many species range over too large an area for the individual to look after - fish throughout a lake, larger mammals may range from one county to another, and many birds from one country or continent to another.

This poses the interesting question of who has jurisdiction over the many species harvested from the world's oceans. Many of these breed and/or reproduce on or near the continental shores - salmon, sea turtles, eels, or migrate great distances - whales, and tuna. This offers complications in their protection. With mans' obvious inability to get along with himself, it is very questionable how successful he will be in preserving the resource of sea wildlife as increasing population places greater demands on sea food and technology provides ever more efficient methods of harvesting.

Commercial pressures, however, are threatening alligators, leopards, etc. (exotic furs) with extinction by illegal hunting. This treats a public resource as a private gain.

Concept #38

Wildlife refuges, undisturbed natural areas and preserves may be of value in protecting endangered species, and thus perpetuating the gene pool:

(This is only a part of their value! See Iltis, High H. "Human Needs & Their Evolutionary Reasons".)

While many animals (e.g. rabbit, fox) have found good habitat in the farmed landscape, others such as wolf, elk, moose, require large wilderness areas for survival. Waterfowl require large wetland areas and their populations are reduced when wetlands are drained. Large wetland areas need to be protected both in the nesting areas and along the flyways.

The rich prairie flora so widespread in presettlement Wisconsin now survives in small areas bought and preserved by such concerned groups as The Nature Conservancy. Plowing, urbanization, and more recently the planting of pine plantations in sand prairie country has destroyed the hundreds of prairie plants which once effected soil enrichment to a degree unmatched by any other plant community. In the few prairies which remain study of this vital process is still possible. The plants provide a gene pool including characteristics such as drought resistance and competition tolerance which may be important to man in his future development of special economic strains. When such a gene pool is cut off, there is no way to replace it.

Evaluation 10-12

CONCEPT #38 - Wildlife refuges, undisturbed natural areas and preserves may be of value in protecting the endangered species, and thus perpetuating the gene pool.

Teaching Activities:

Assume that a resource such as oil had been discovered in an area that was considered a natural area. In this area there exists the largest natural population of a species such as the grizzly bear. If the area is to be developed for oil resources, the grizzly bear population will be drastically reduced.

Have students organize into two teams and present arguments pro and con concerning the drilling for oil on this land. Allow students adequate time for reference work.

Knowledge 4-6

CONCEPT #38 - Wildlife refuges, undisturbed natural areas and preserves may be of value in protecting endangered species, and thus perpetuating the gene pool.

Teaching Activities:

The official state map shows the locations of state owned lands. Have the students develop a list of state owned lands and the kinds of wildlife that are prevelant in each area. By writing to the management of the area, the class may determine why the area was purchased by the state.

Concept #39

Environmental contamination can be attributed to increasing human populations, rising standards of living, and the resultant demands for greater industrial and agricultural productivity:

If man could successfully prevent contamination of his environment and stabilize the human population now at around 3 billion souls, he could probably increase his material standard of living for the indefinite future. That is, if he could solve his political, social, cultural and racial differences. Unfortunately these last four problem-producers are severely compounded by the fact there is no relief in sight from rapidly increasing pressures from both additional environmental contamination (physical, chemical and thermal) and ever-more people* (1,500,000 per week - an additional Chicago per month, for the world).

The pressure from increased population for more food has made it highly profitable to manufacture potent pesticides. The main two questions are: is the chemical cheap? and does it do the job? If both answers are yes, the incentive is great to use it. First, profit is made by the chemical manufacturer and second, more food becomes available.

In the affluent U.S.A. there is great competition by farmers, wholesalers and retailers for the consumer dollar. So, many many pesticides are used to produce salable food but probably less safe to eat than if it had a few bug bites on it.

One of the cardinal principles in nature is that all elements that enter into life processes (carbon, hydrogen, oxygen, nitrogen, phosphorous, potassium, and 30, or so, others) are cycled and recycled. This fundamental principle has been completely ignored by modern technological man. He has injected foreign substances (radio-active fallout, hard pesticies - DDT compounds, plastics, etc.) which do not biologically break down readily. That is, they are not biodegradable as, for example, is sugar which is made up of carbon, hydrogen and oxygen and is easily converted by both plants and animals to carbon dioxide and water.

Many of the approximately 500 additional chemicals introduced every year are both toxic and non-biodegradable and hence can accumulate. And additionally can interact with each other or react in the environment to form new chemicals as in the case of sunlight producing new photochemicals from poisonous gas from car exhausts.

The natural environment is large and can absorb a reasonable amount of intrusion. But we should be aware of the vast number of chemicals

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*See Concept 3 for further data on world population increase.

(Continued . . . #39)

being introduced, plus the fantastic toxicity of some (a few parts per billion), plus the enormous conplexity of the ecosystem. In a word, man has achieved the scientific sophistication to synthesize these chemicals so highly toxic to living cells, but he has not achieved comparable scientific sophistication in - nor devoted the effort to - sorting out the actions, interactions and end results of these chemicals in the environment and in man himself. In too many instances, environmental breakdown is the first indication that a given chemical is too dangerous.

Socrates once said "The unexamined life is not worth living." We might rephrase that today to "The unexamined environment is not worth living in."

Animal wastes: In U.S. the high standard of living and increases in population is reflected in the great increase in meat producing animals. This in turn is creating a monstrous waste disposal problem. Farm animals in the U.S. produce ten times as much waste as the human population. (One cow generates as much manure as 16.4 humans, 1 hog as much waste as 1.9 people, etc.) The major unsolved problem in confined housing of farm animals is the handling and disposal of manure. In some areas nitrate levels in ground water has been found to be above the toxic level and this has been attributed to manure storage and handling methods in the area. The possibility of development of high densities of certain pathogenic organisms and the spread of these in dust of dried wastes is a cause for concern. Intensely offensive odors of animal wastes have compelled some farmers to go out of operation.

Heat pollution: By 1985, it is estimated that the electric power industry will be passing through its heat exchangers about 25% of the nation's total supply of surface water. By the year 2000 generated power could reach 1.6 million Mw (today 400,000 Mw). (Heating of rivers and lakes by return waters can favor some living things and be fatal to others. - More study needed as to overall effects.)

CO_2 being added to air by fossil fuel burning at rate of 6 billion tons/year.

Noise pollution is an increasing problem. Effects on hearing being studied. More needs to be known on effects on nervous system.

A basic philosophy of acquisition seems to pervade the affluent society. Most vital is the rechanneling of this affluence toward maximizing individual creativity, enjoyment of arts, continuing education, etc. - acquiring wisdom and culture rather than goods.

Scrap iron and steel are generated at a rate of 12 to 15 million tons a year. - 1/3 of this is used cars.

From 25 to 30 million tons of paper products produced annually-about 10 million tons of waste paper were salvaged in 1964 to make new paper.

(Continued . . . #39)

Each year in the U.S. we must dispose of 48 billion cans (250 per person), 26 billion bottles and jars (135 per person), 65 billion metal and plastic caps & crowns (338 per person), plus more than half a billion dollars worth of miscellaneous packaging material.

In 1963 more than 3.3 billion tons of waste rock and mill tailings were dicarded near mining sites.

Estimate 1600 pounds per person per year of urban solid wastes. Collection and disposal of this nation-wide costs 2.5 billion dollars a year.

Knowledge K-3 4-6

CONCEPT #39 - Environmental contamination can be attributed to increasing human populations, rising standards of living, and the resultant demands for greater industrial and agricultural productivity.

Teaching Activities:

Illustrate (through the use of charts), the types of electrical appliances available twenty-thirty years ago. Do the same for appliances that are electric today. In the lower grades, one may want to compare numbers to see that our need for electrical power is greater. In the higher grades, one can compute the electrical power needed (KWH) to operate our present day appliances and compare to the power needs of decades ago. Through this activity, one can then grasp the thought that we have created a greater demand for electrical energy and the way this energy is produced, whether by coal or atomic energy sources, is going to increase our pollution capacity.

Comprehension 4-6 7-9

CONCEPT #39 - Environmental contamination can be attributed to increasing human populations, rising standards of living, and the resultant demands for greater industrial and agricultural productivity.

Teaching Activities:

Prepare a chart in which leisure activities are shown for people of today compared to leisure activities twenty years ago. Illustrate the types of pollution involved in activities of each age. This same format may be used to show ways in which our working day is easier because of a rising standard of living. Through identifying the types and sources of pollution involved during each age, the student can comprehend how changes in the standard of living also affects pollution - directly and indirectly.

Analysis 10-12

CONCEPT #39 - Environmental contamination can be attributed to increasing human populations, rising standards of living, and the resultant demands for greater industrial and agricultural productivity.

Teaching Activities:

To demonstrate the affect of a population on increased pollution, you may use yeast and culture them in in fermentation tubes where the production of carbon dioxide can be measured. Population counts can be made under the microscope. By interpreting the data, one may see the CO2 content increase as the population increases.

CONCEPT #39 - Environmental contamination can be attributed to increasing human populations, rising standards of living, and the resultant demands for greater industrial and agricultural productivity.

Teaching Activities:

Have the students list the conviences they have that ultimately contribute to pollution: Example:

electric power
transportation
packaged materials
beverages

Then ask them to pick the ones they would be willing to give up.

What substitutes could be made?

Why is man referred to as "swinus americanus"? How can we correct this?

CONCEPT #39 - Environmental contamination can be attributed to increasing human populations, rising standards of living, and the resultant demands for greater industrial and agricultural productivity.

Teaching Activities:

Through an increase in our population, and a change in the kinds and numbers of nonreturnable containers, the littering problem is in our midst. Survey an area of your choice and determine the types, (glass, paper, metal, etc.) and number of containers or other items found as litter. Predict consequences of littering, and interpret data to determine which kinds of litter present the largest problem. Discuss ways of providing littering. (Recycling of some packaging materials like bottles and cans, and changes in personal behavior)

Concept #40

Pollutants are produced by natural and man-made processes:

Pollution means different things to different people and, therefore, has a number of definitions. Webster's Dictionary defines "to pollute" as, "to make or render impure or unclean ceremonially, physically, or morally." By this definition, the chemist's pure DDT would be rendered impure and hence polluted by the addition, including distilled water, of anything except more pure DDT. That would be a new twist - polluting a pesticide with pure clean water. Or, motor oil would be physically polluted by the addition of sand.

But we are studying man in his natural environment. So, we are concerned with an ecological definition of pollution - a relative, not an absolute condition. This definition requires an absolute objective standard not a relative subjective one. An ecological definition: the degree of chemical or thermal pollution is proportionate to its direct or indirect negative affect on native species. Within this context, we can discuss pollutants from both natural and man-made processes.

Let us consider nutrient enrichment of a lake. Nutrients enter the lake as a natural process from fish, amphibians, aquatic birds and other aquatic animal life as well as from decaying plant life. Also water runoff into streams carries in dissolved mineral nutrients and nutrients from animal wastes. Rain brings in nitrogen dissolved from the air. All these are sources of pollution by out definition because they do affect the native species in the lake. But they can only be pollutants in proportion to their negative affect on the lake's species. Such nutrient addition, however, is part of the natural nutrient recycling phenomenon. Which, if entirely shut off, would eventually eliminate all life from the lake. So, because the affect of the nutrient addition is positive (not negative), these natural nutrients are not pollutants by our definition.

On the other hand, if man makes massive nutrient additions to the same lake through urban sewage and nutrient runoff from farm mineral fertilizer and manure, the same native species are very differently affected. The algae and other aquatic plants are just as responsive to these nutrient additions as corn plants, lawn grass or rose bushes. Problems arise in the lake because the aquatic plants grow faster than the grazing animals can consume them. The excess plant growth eventually dies, sinks, and decays. The organisms which decompose the dead plant material do not carry on photosynthesis because they obtain their energy from the dead plant material, - not directly from the sun. But like all forms of life, the decaying organisms carry on respiration and so consume the dissolved oxygen. The oxygen deficit asphyxiates the organisms both on the bottom and in the bottom ooze. (See attached diagram)

Knowledge K-3

CONCEPT #40 - Pollutants and contaminates are produced by natural and man-made processes.

Teaching Activities:

Demonstrate that fire and man produce some the of the same by-products which can be considered pollutants. Water vapor and CO2 from each source can be shown. (Use cold glass for moisture collection and the limewater test for CO2)

Comprehension 4-6

CONCEPT #40 - Pollutants and contaminates are produced by natural and man-made processes.

Teaching Activities:

Bacteria in the air, traveling on dust particles, represent a type of natural pollution. Investigate the areas that may be significantly affected by this type of pollution by exposing sterile nutrient agar plates to different environments for controlled periods of time. Incubate and count bacterial colonies. Graph and interpret results.

Evaluation 7-12

CONCEPT #40 - Pollutants and contaminates are produced by natural and man-made processes.

Teaching Activities:

As a class, prepare a working definition for pollutants and contaminates. When a working definition is available, prepare a list of man-made and natural forms of contamination producing means. (Some natural forms one could consider are: volcanoes, bacterial by-products, forest fires, erosion, decay of organic materials, etc.) through individual or team work, explore the methods of pollution and prepare models, charts, written or spoken reports of your findings. Note the nature of the pollution, amounts, distribution of the sources worldwide, mans' affect on the severity of the pollution and methods of prevention.

This activity would also work well on a field trip, where your pollution-contamination definition can be put to use in the local community, searching for sources of natural and man-made pollution, methods for pollution reduction or prevention could be studied at the same time.

CONCEPT #41

Water is a reusable and transient resource, but the availability of quality water may be reduced or impaired:

Certain lower forms of life survive without oxygen. All forms of life, at least on this planet, require water to survive and reproduce. Man can go many weeks without food but only a few days without water. Clean air and clean water are mans' two most important natural resources. Yet look at what we have done to Lake Erie, one of the world's great freshwater lakes.

Through a mismanagement and abuse, we have converted a clean, blue lake into an aquatic desert, listless and murky green.

In 1900, the whole U. S. sewage system discharged less than 10 million pounds of phosphates annually. By 1964, the discharge totalled 250 million pounds, with synthetic detergents being a major contributor. The National Research Council warned two years later that by the mid-1980's, the nation's municipal wastes are expected to have a biological demand equal to the oxygen available in the entire summertime flow of the nation's river systems. In other words, if the nation's mid-1980 municipal water were uniformly dumped into the country's streams and rivers, the water's dissolved oxygen would be completely depleted and all aquatic life exterminated.

Finally, the so-called clean power from nuclear energy has two harmful waste products: lethal and crippling radioactive wastes and the discharge of heated water used in the cooling process. Thermal pollution reduces dissolved oxygen levels and encourages algae growth - illustrating again that we cannot get something for nothing.

Changes similar to those in Erie are occurring in Lake Michigan. Ominous is the accumulation of insecticides. Just as we failed to grasp what was happening in Lake Erie until too late, we never realized DDT and related insecticides move as readily as they do through the biosphere. Nor did we realize until recently that DDT, being nearly insoluble in fat, is concentrated in the fatty tissues of predatory animals on up the food chain. Coho salmon are at the top of the food chain in Lake Michigan. Their eggs have such high concentration of DDT that salmon reproduction has been severely disrupted. Table illustrates this biological concentration.

TABLE
DDD (a breakdown product of DDT) entered Clear Lake, Calif. at .02 ppm. Concentrations were as indicated 13 months later (5).

Organism	Parts per million (ppm)	Increase over initial concentration
Plankton	10	500x
Fish that live on plankton	903	45,000x
Fish that eat fish that eat the plankton	2,690	134,500x
Birds that eat fish that eat the plankton	2,134	106,700x
Man, who stands at the food chain's top	??	??

Concept #41 . . . Continued)

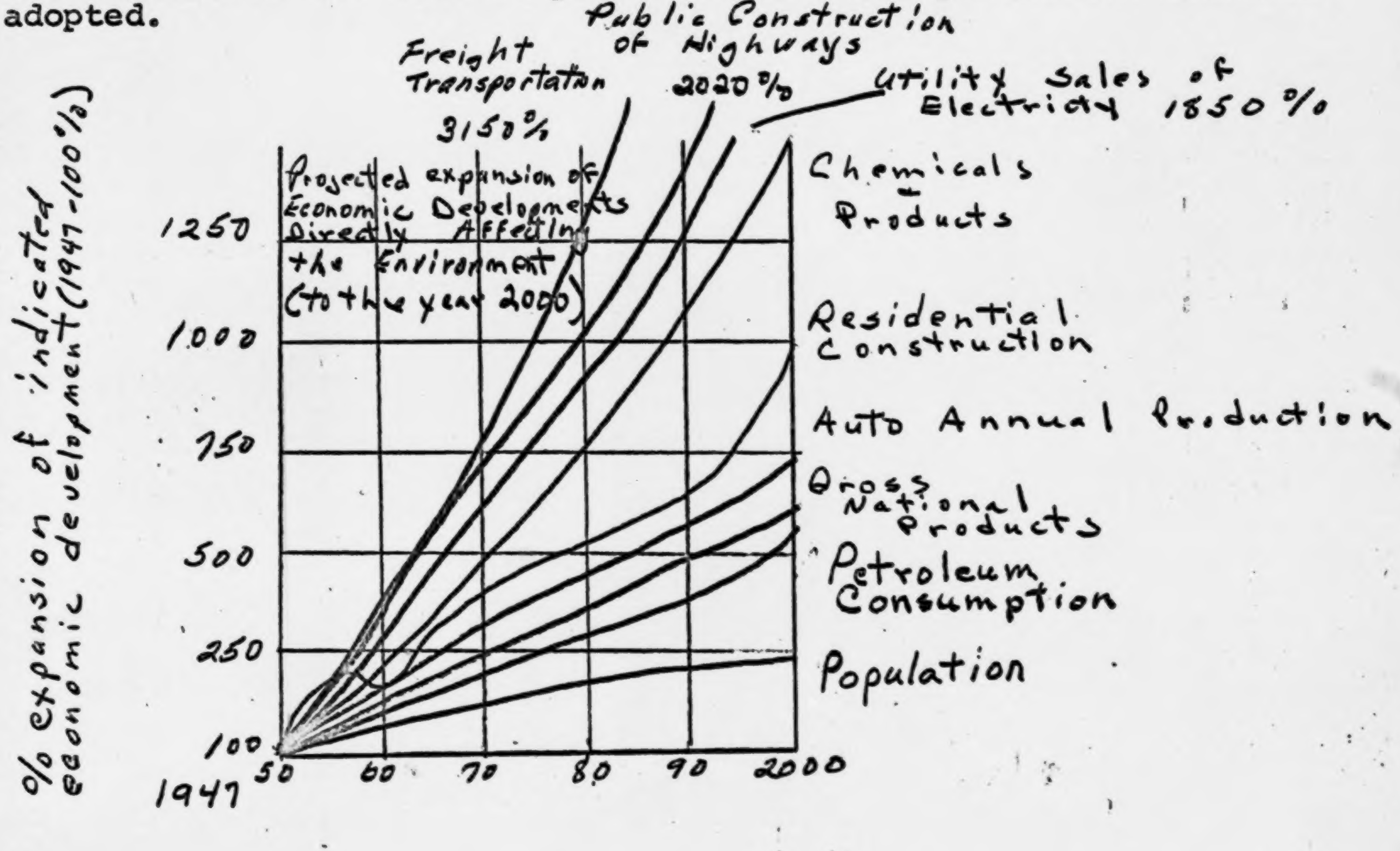
A similar study was conducted at the Hanford, Washington, atomic power plant on the Columbia River. Small amounts of various isotopes were released into the water and followed in natural food chains. Hanford scientists found that radioactive phosphorous appeared in eggs of ducks and geese in concentrations 200,000 times higher than the solution released into the water, and occasionally 1.5 million times higher. Although the eggs hatched, the genetic damage to the species hasn't yet been determined.

DDT and/or its derivatives have been found in surprisingly high concentrations in Antarctic penguins (19-83 ppm), Bermuda petrels (58 ppm), Artic peregrine falcons in northern Alaska (414 ppm), and California bald eagle fat (2,800 ppm), in every fish so far sampled by the Wisconsin Department of Natural resources and the University of Wisconsin, and is widespread in oceanic fishes (6). Even atmospheric dust sampled over the Caribbean isle of Barbados has its share of DDT - 14 ppb (3).

What about the half-million chemicals the FDA estimates we are now exposing ourselves and our environment to? FDA estimates the number is increasing by 400 to 500 per year (see Figure 3). We are begging the question of how these chemicals directly affect us and all other organisms. But what are the possible effects of various chemicals in combination? We just do not know.

Aldo Leopold (7) wrote 20 years ago: "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise." Many of the chemicals we are using are destroying or dislocating biotic communities.

Figure indicates the extent to which Americans will pollute the environment in the next 30 years unless broad protective measures are adopted.



(Concept #41 . . . Continued)

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What comfort can we derive from the fact that our Gross National Product is expected to double in the next 20 years? After comparing socio-ecologic environment in the U. S. and the world in 1949 and 1969, I see little cause for optimism for 1989 unless our national and world values change. When a GNP is sufficient to meet its peoples' basic biological and social needs, the value of a growing GNP depends on the values, wisdom and goals of the nation producing it. We are still selling our virtue to buy wealth. For our own long-term survival, we must chart and follow a course designed "...to preserve the integrity, stability and beauty of the biotic community."

2/3 of U. S. population (125 million people) are served by domestic sewers. Sewage from 1/10 of these people is discharged raw and that from more than another 1/4 after only primary treatment. Because of failure of systems, etc. in addition, in total the sewage discharge corresponds to raw sewage from almost 50 million people.

Sewage effluents, treated or not, contribute to over fertilization of lakes and rivers, causing algal blooms, excessive plant growth, foul odors and sometimes fish kill. Detergents add to this problem - degradable or nondegradable - all add phosphorous, a plant nutrient.

Industrial pollution:

Strip mining in the Appalachian area has resulted in severe acid contamination of streams.

Taconite mining now threatens the purest of the Great Lakes - Lake Superior. Paper industry and cheese industry in Wisconsin have been big water polluters. Tightened controls on nitrite release by paper mills resulted in development of economically profitable recovery process.

Ruhr Valley in Germany best current example of clean-up of polluted river in big industrial area. The Ruhr Valley Authority was organized (a quasi-governmental organization including the industry involved) which proceeded to work out a system of effluent charges - an industry or municipality discharging into the river is charged according to quality of its discharge - the more contaminated the more expensive. The collected funds are used to clean up the water. Under the system many of the companies have found it more profitable to do a good clean-up job themselves. The river is now reported to have changed from one of the most polluted to a stream in good condition.

A provocative suggestion is that each community or industry might be required to have its intake pipes downstream from its discharge pipes.

Pesticides, heat pollution, manure problems, and siltation discussed elsewhere.

Dilution is not the treatment for pollution.

A serious ethical question is whether anyone or any group of people has the "right" to use public waters to dispose of their wastes. Financial incentives (for anti-pollution expense) to industry has become a political way of life but there is legitimate doubt as to whether it is right to pay a company to do what it should be responsible for doing anyway.

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Knowledge K-6

CONCEPT #41 - Water is a reusable and transient resource, but the availability of quality water may be reduced or impaired.

Teaching Activities:

For your community, determine which industries are users of this resource. Then visit each industry to discover what purification processes, if any, are necessary before the water is used, and in what condition the water is returned to the environment.

Application 7-9

CONCEPT #41 - Water is a reusable and transient resource, but the availability of quality water may be reduced or impaired.

Teaching Activities:

Using indicator organisms, such as the trout, make a survey of the quality water now available in your community, region, county, or state. Contact the Department of Natural Resources for information on trout streams in Wisconsin and what is happening to their numbers. Also note what is "killing" each stream when possible.

Analysis 7-12

CONCEPT #41 - Water is a reusable and transient resource, but the availability of quality water may be reduced or impaired.

Teaching Activities:

A visit to your city water station, at any grade level, will be enlightening on this concept. Even ground water, pumped from several thousand feet down, will in many cases not be at the purification standards set up for citywide consumption. Discussion of increased demands and methods of purification of city drinking water can be obtained at the station. Further interpretation and illustration of data obtained on such a trip can follow in the classroom.

Concept #42

Processes such as erosion and deposition will modify the landscape:

Two primary forces are responsible for modifying the earth's contours - wind and water. These forces are aided by weathering, the freezing-thawing, heating-cooling, and dissolving of parent rock. All the processes require a constant energy input and they all have a common source - the sun. Without the sun, water would not be evaporated from water bodies to be precipitated later on the uplands nor would there be thermal imbalances for the winds to attempt to correct.

Working water cuts and carries on its way whatever is movable. The materials it picks up act as an abrasive helping to cut away deeper or wider channels. The river swings back and forth over thousands and millions of years which may carve a flat river valley hundreds of times as wide as the river itself. This valley may then be a flood plain as well.

It is this process known as base-leveling, that operates upon whatever surface pattern is afforded by shifts due to internal forces of the earth. Like all physical processes, it moves in the direction of a pattern of minimum stress - less at the base of the mountain. And the forces within the earth itself attempting to minimize stress have created the mountains which has renewed the erosion-deposition cycle.

The great rivers flowing eastward from the Rockies - the Missouri, Platte, Arkansas, Rio Grande - cross the great plains and have contributed heavily to the fine deposits which are hundreds of feet thick in places. In a similar manner, the Himalayas have contributed to the building of the great fertile plain of India to the south. The Alleghenies reflect their greater age than the Rockies by their rounded hump-backed appearance.

Man, in the last few centuries, has increasingly aided the forces of erosion - wind and water. He has degraded the natural vegetative cover through lumbering, grazing, plowing and building homes, factories and highways. The difference is that natural erosion is on a geological time scale to which the biota can easily adjust. The major portion of man's destructive activities have occurred entirely within a single lifetime of many living organisms.

(Shouldn't this one be a general geology concept rather than a pollution one?) This is one of the basic geologic processes which has shaped the present landscape and ever continues its wearing down of the mountains and filling in of the valleys and lakes. In northern Wisconsin once were lofty mountain peaks. Over millions of years, even these large mountains were reduced to a nearly flat surface or peneplain.

(Continued . . . #42)

Erosion of the Niagara limestone at Niagara Falls now threatens the existence of Lake Erie, the shallowest of the Great Lakes. In the normal slow geologic process, those rocks, which have formed a dam causing the waters upstream to spread out into a lake, would wear away and finally allow the lake waters to drain out, leaving only a river channel in the basin of the lake. For lakes with an outlet, this is what the long term future always holds.

Increased siltation as a result of poor watershed practices by man can cause a rapid delta formation and filling in of the lake into which a stream flows. Aerial views of Wisconsin streams flowing into lakes in developed areas show this strikingly.

Lakeshore property owners whose piers now stand in silt instead of water can also nouch for this effect.

Poor farming practices can cause severe gullying and loss of soil. Grazing of hillside woodlots may cause siltation over good fields below.

Siltation into man-made lakes is often very rapid, making such lakes very short-lived.

CONCEPT #4.2 - Processes such as erosion and deposition will modify the landscape.

Teaching Activities:

Find a field where there is a fence built across the slope. Compare the height of the land at the fence row with that in the field down the slope. To do this, attach a string to a stake driven in the ground above the fence row. From a spot down the slope, pull the string parallel to the ground line above the fence and measure from it to the ground.

What has happened to the soil that has been eroded away? What is the affect on the area that the soil eroded to? How has the soil productivity been changed?

CONCEPT #42 - Processes such as erosion and deposition will modify the landscape.

Teaching Activities:

With the application of the "scientific model", you may demonstrate the effects of erosion and deposition on a small scale. In conjunction with this, a field trip would be desirable to see actual land form changes as wrought by erosional and depositional processes.

The "models" are designed by student teams and are made by putting soil in wooden troughs* and building the land forms on this soil. Water is added to the trough in either a rain affect or stream affect, whichever method your experiment calls for. Things to be tested include: affect of slope, amount of moisture, amount of runoff, type of cover, affect of conservation practices like terraces and waterways, etc.

*Four-foot sections of flat bottomed eavestroughs work well, especially with a V-mouthed end put on each piece.

CONCEPT #43

Atmospheric contamination causes physical and chemical changes on earth and affects living things:

AIR

Air pollution now costs every American $65 per year in property damage. Moreover, air pollution takes thousands of lives prematurely by aggravating bronchial ailments. Yet, the total 1969 Congressional outlay for air pollution control is about 45 cents per person.

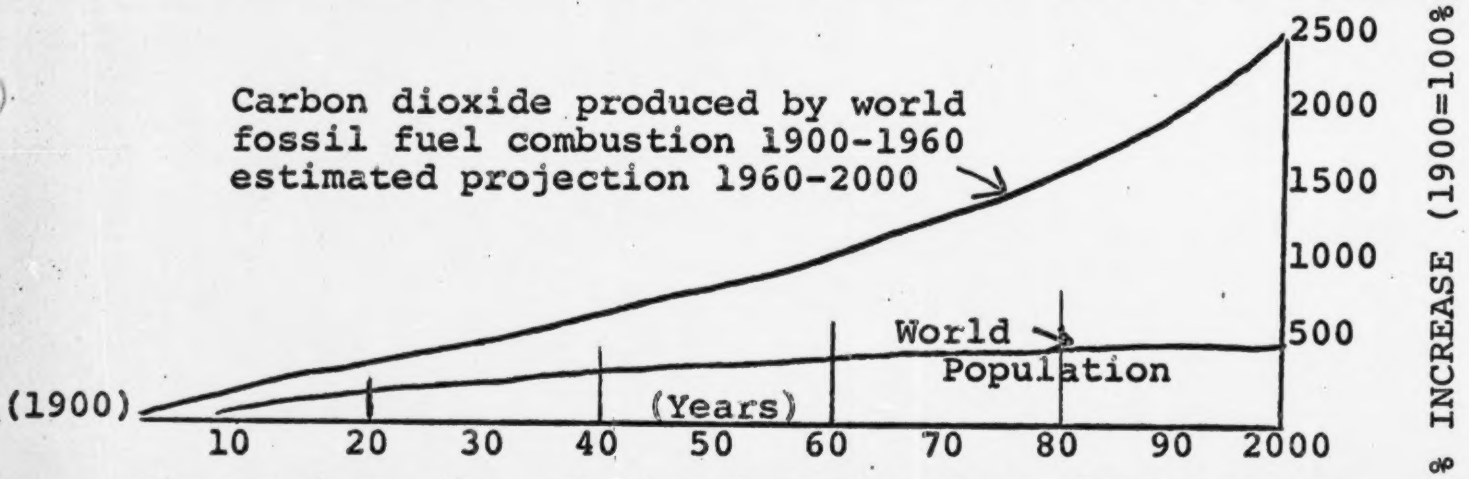

Figure shows the relative increase in world population and combustion of fossil fuels (coal, liquid hydrocarbons, natural gas and lignite) (2). The carbon dioxide curve is presented as an indication of mans' ability to release long-stored energy into his environment, energy that throws the environment into ecological disarray. With more and more energy available, man is able to plow, cut, net, mine, or bulldoze for the quick dollar. We are accumulating waste by-products roughly at the rate the CO_2 curve is ascending. So, environmental degradation is progressing considerably faster (see Figure in Concept 45) than the population increase depicted by Thomas Malthus in 1798.

The climatologists are not in complete accord in their interpretation of the significance of atmospheric CO_2 accumulation. It has been suggested that atmospheric warming due to an increased CO_2 "greenhouse effect" could melt the Antarctic ice cap and raise sea level 400 feet. If this takes 1,000 years, and it could occur sooner, the seas would still rise four feet every decade, and in 30 years many of the world's great seaports would be largely inundated. Indeed, between 1885 and 1940 the average surface temperature over the entire earth showed a rise of .9°F. But between 1940 and 1960 the temperature dropped .2 F. Some scientists attribute this increase to the abrupt increase in the atmospheric dust (3). Unfortunately, it is nowhere near as simple as one injection negating the effects of a second. Atmospheric dust and CO_2 have quite different effects on such important factors as light quality and intensity, photosynthesis, plant and animal respiration, wind velocity and direction, and water acidity.

One estimate of the various pollutants being released into the air is presented in the following table.

(Concept #43 . . . Continued)

TABLE
ESTIMATED U.S. AIR POLLUTION TONNAGE PER YEAR

Source	Millions of Tons	% of Total
Cars, trucks and buses	85	65
Manufacturing industry	22	17
Electric power plants	15	12
Heating of homes and buildings	8	6
Total	130	100

Increasing levels of CO in the air as a result of the burning of fossil fuels may affect the earth's climate by reducing the loss of radiant heat from the earth. This might result in melting of glacial ice, flooding of coastal cities.

Dust in the air is thought to have a cooling affect on earth because it interferes with reception of solar rays.

Episodes of acute and fatal air pollution:

December 1930 - Meuse Valley, Belgium. 60 deaths attributed to smog, hundreds ill.
October 1948 - Donora, Pa. 17 deaths from smog. Oxides of sulfer and other fuel combustion residues thought to be responsible.
December 1952 - 4000 deaths due to severe air pollution as a result of fog and temperature inversion

Industrial lung diseases among plastic workers etc. are an increasing problem. Effects of asbestos fibers (strongly associated with lung cancer) on the urban population is causing increasing concern. (Asbestos fibers are used in automobile brake linings)

Urban smog chemicals damage spinach and tabacco plants.

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CONCEPT #43 - Atmospheric contamination causes physical and chemical changes on earth and affects living things.

Teaching Activities:

Demonstrate that fire and man produce some of the same by-products which can be considered pollutants. Water vapor and CO2 from each source can be shown. (Use cold glass for moisture collection and the limewater test for CO2)

CONCEPT #43 - Atmospheric contamination causes physical and chemical changes on earth and affects living things.

Teaching Activities:

To indicate a physical change of atmospheric contamination, wet five pieces of cloth, one for each school day, and label them. Hang the damp pieces of cloth outside at the beginning of the week and bring one in each day. Interpret results. You may be able to identify some of the types of contamination. Apply results to affects that this type of pollution would have on man and his possessions.

CONCEPT #43 - Atmospheric contamination causes physical and chemical changes on earth and affects living things.

Teaching Activities:

Working individually, or in teams, set up some artificial atmospheres in airtight containers and notice their affects on living and nonliving things. (You may try paints, metals, daphnia, or other simple living things.) Some pollutants which can be made, or obtained include carbon dioxide, sulphur dioxide, auto exhaust, etc. Renew pollutants periodically and have a suitable control (no air? clean air) for comparison. Record keeping becomes necessary and should be kept up for long periods of time. Depending on the age level, you may want to try the concentration level of one pollutant rather than a variety of pollutants. Also, you may wish to analyze the affects of various pollutants in dry air compared to moist air.

CONCEPT #43 - Atmospheric contamination causes physical and chemical changes on earth and affects living things.

Teaching Activities:

Investigate the types of byproducts formed by various atmospheric contaminants. Example: $CO2 + H2O$ carbonic acid. Sulphur dioxide changes to sulphuric acid. The advanced groups, after having identified pollution byproducts may then test the affects of these byproducts, at different levels of concentration, on metals, paints, woods, and living things.

Concept #44

Man has responsibility to develop an appreciation of and respect for the rights of others.

This concept is a restatement of the Golden Rule, "Do unto others as you would have others do unto you". If all industries, businesses, and individuals would be mindful of the rights of others, environmental problems would not be so rampart.

Man, being a materialistic creature, too often looks for short term gains without regard to long term consequences. Known pollutors of our waterways and air are allowed to continue to pollute because to stop pollution would mean increased prices for products - in the case of industries.

Values and principles pertaining to human conduct tend to come into conflict. Individualism, so highly esteemed in this country, must come to terms at a hundred different points in the culture with the common good and with common interest. No man can live to himself alone. He must respect the rights and privileges of his neighbors as well as his own. Property rights are not absolute rights. In managing and using natural resources, the people of this country must seek to maintain an appropriate balance between overall common good and opportunity for the individual to exercise initiative.

Knowledge K-3

CONCEPT #44 - Man has responsibility to develop an appreciation of and respect for the rights of others.

Teaching Activities:

Create "Don't be a litterbug!" posters and slogans and display them in your town, school, or campgrounds.

Application K-6

CONCEPT #44 - Man has responsibility to develop an appreciation of and respect for the rights of others.

Teaching Activities:

Arrange a walking field trip between the school and the downtown area. (This will be especially effective after a weekend activity.) Prior to the trip, develop the idea that littering of streets and park areas is usually done without any real intention on the part of the person littering. Collect litter along the route. When you return to class, discuss the length of time it would take for representative kinds of litter to be decomposed.

Students can create "Don't be a Litterbug" posters and slogans and display in the room, school or community.

Application 4-6

CONCEPT #44 - Man has responsibility to develop an appreciation of and respect for the rights of others.

Teaching Activities:

Remove the wastebasket from the classroom for just one day and allow the children to throw their wastepaper on the floor under their desks. The children will see how easily a whole room can become unsightly in just a short time. The time it takes to clean up the room can be measured and children can compare this with other things they might have been able to do during that period of time.

CONCEPT #44 - Man has responsibility to develop an appreciation of and respect for the rights of others.

Teaching Activities:

Investigate the rights of property owners, compared to the rights of sportsmen to use natural resources. Students may formulate a code of ethics which the landowner should follow, as well as the fisherman, hunter, or snowmobilers, etc. You may expand on this and evaluate the responsibility of the individual in protecting our forests from fires or other damage. Some students may be able to explain the use and issuance of "burning permits" in rural areas.

CONCEPT #44 - Man has responsibility to develop an appreciation of and respect for the rights of others.

Teaching Activities:

Waste disposal is everyones business. When aggregations of people exist, large areas need to be set aside for disposal of waste in a manner that will be safe, least objectionable aesthetically, and an eventual asset to the environment. Investigate the problems associated with a sanitary landfill. Consider the landowner, neighbors, soil types, ground water, wildlife, aesthetics, and long range affects of such a program. Through panel discussion, student reports, or other communicative means, bring out the merits, and demerits of this type of waste management program. One may want to compare it to the "town dump" method, as well as other methods, such as incinerators.

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